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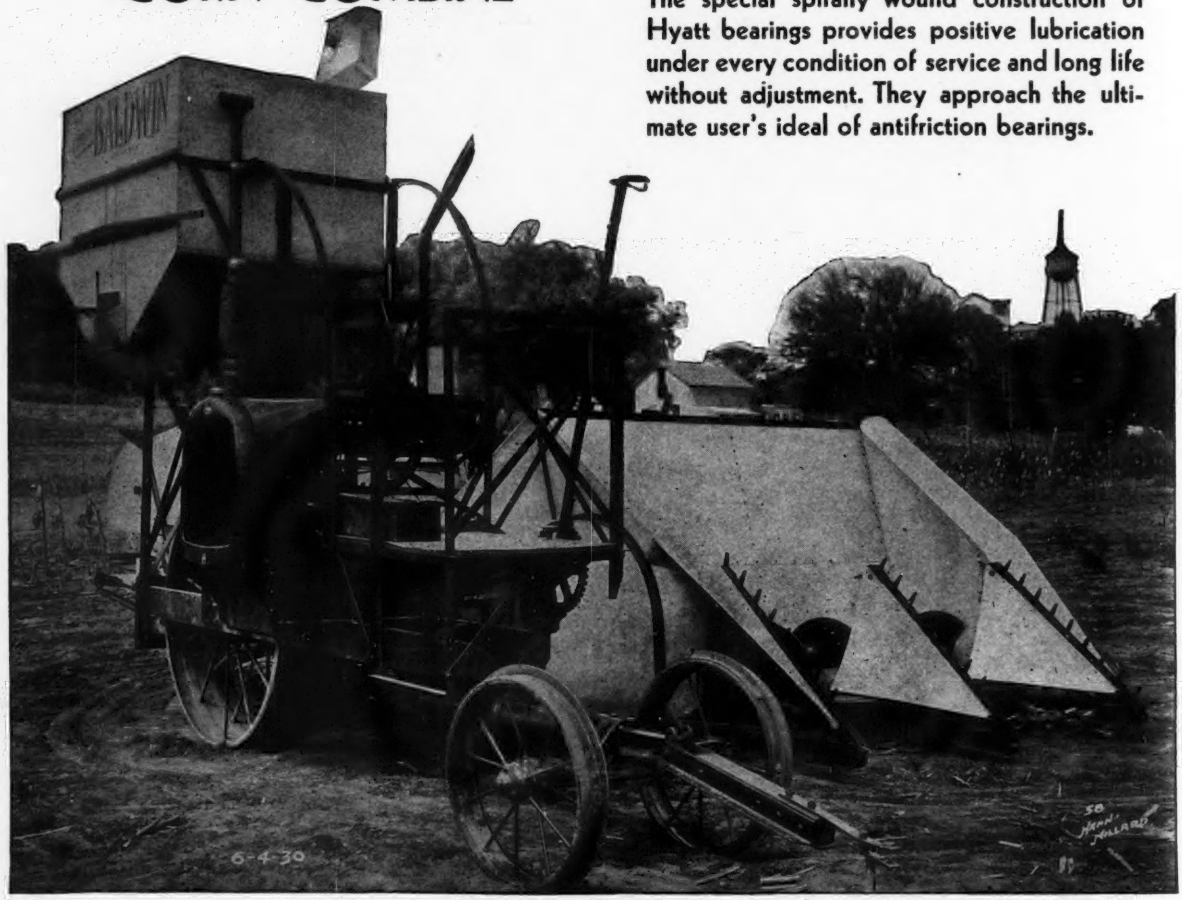
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AGRICULTURAL ENGINEERING

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Fundamentals of Engineering Research[1]

By C. F. Kettering[2]

WE SOMETIME or for some reason have put the cart before the horse in engineering and research and everything else. We have been more interested in the way in which the thing is done than in the thing itself. In every research program that we have I always make a fellow write down what he is hoping to accomplish—what is this all about?—and after the smoke has blown away and the job is done, what good is it? What is the idea behind it all? It is surprising to find out how many things dissolve in that acid test. A lot of times I have found out that the smoke covered up a new piece of equipment they wanted to buy.

C. F. KETTERING

You know the problems that exist in the world just exist, just like a rock down in the ground, and if anyone is going to get them out he has got to dig around them and lift them out. This idea of creating new problems to my mind is very fictitious. Every industry in the world has some problems. Maybe the agricultural business and the agricultural engineering business hasn't any problems, but any industry I have been associated with has. And it is in the economic solution of those problems that engineering and research came into the picture. Now I want you to get that: "In the economic solution of those problems." Some fellow develops a method, he puts into the laboratory a dynamometer or some other thing and out of that comes a certain result which helps. And then, just like a bunch of sheep, we all want to go and do exactly the same thing. It is a magic incantation; you go through a formality and the result comes out. Each one of us must solve his own problem in the way it fits into his own affairs. I have seen more mistakes made in trying to do engineering research than any other single thing.

In the first place, let us say a board of directors has come to the conclusion they are going to put in a research department and they hire a fellow. The first thing he wants is a laboratory—and that is about the last thing he may need. The first thing he needs to do is to find out what he wants to solve. No one needs a laboratory to go out where the thing is and find out what it is and get acquainted with it. After that it can be solved. Maybe a pair of tin snips and a soldering iron is all that is needed to do the work. But I am so sick and tired of this trying to high-brow a thing which is just low-brow—and low-brow means just common sense. I object to two terms applied to research engineers. One is "high-brows" and the other is "nuts." Neither title gets anybody any place. Here is the way we analyze a problem:

There is a difficulty, a problem to solve, and now what is it? We must analyze that problem and find out the limiting factors. What isn't known about it? That can be done on a piece of cardboard or blackboard or anything. Here is the difficulty: What is wrong? Let us cancel off what is good. Assume it is a tractor with which we are having trouble. Why? Is it the engine? All right. Finally we get down to something.

Now is that because a part isn't right, or is it because the part isn't shaped right to fit the operator? And by "fitting the operator," I mean is it over his head, is it too technical, or doesn't it fit him physiologically? But let's find out what the limiting factor is. Then, when we get all that down, it may be a metallurgical problem, it may be a design problem, but it isn't going to be any great big complicated problem. It is going to be a simple problem which can be allocated to some definite line of research. If it is a metallurgical problem it calls for a metallurgical laboratory. That is the place to get a laboratory. And there is always some small hole some place that that laboratory can be placed. An organization starts down the wrong road the fastest when it goes out and builds a beautiful laboratory when it hasn't anything to put in it.

I want to tell a story. One of the greatest pieces of research ever performed in the world was done by Dr. Rosneau in a western university. Dr. Rosneau developed the principle of focal infection. By that I mean, if a person had a certain abscess of the liver and it was injected over into another person, he would have that same abscess of his liver. In other words, these infections go to a perfectly definite place. Now he wanted to do that research work in the university in which he was located, but the dean of the department of medicine didn't think it amounted to anything.

And, incidentally, that is another very important thing. No research problem at the time it is proposed looks sensible. He wanted to do this job and he couldn't because he didn't have any room. And the next thing he wanted was a microscope, and they couldn't permit him to use one of the college microscopes. But the janitor had a space for buckets under a stairway going down into the basement, and so this enterprising young fellow got on good terms with the janitor and got him to keep his buckets some place else. He then had a room under the stairway with a little window. Then he found a lot of apparatus which had been thrown away, and he picked out enough parts to assemble a microscope. He solved this problem and that is one of the bright spots in that university's service to humanity.

Now the point I wanted to make it this: The research problem is not solved with the apparatus; it is solved

[1]An address before the 24th annual meeting of the American Society of Agricultural Engineers, at Moline, Illinois, June 1930.

[2]President, General Motors Research Corporation.

in a man's head. No one ever solved anything in a research laboratory. The research laboratory is the means by which, when a man has an idea clarified in his head, it is possible to do the solving of it. And from that point of view I will tell you about this apparatus business.

A fellow wants to buy a lot of apparatus and I tell him, "You must have a very, very thick head." He asks, "Why?" "Well," I say, "you know these problems are solved in your head, and evidently it takes all this apparatus to get an idea from the outside into your head, so the more equipment you have is simply an indication of the density of the material through which the idea must penetrate."

Somehow we get imbued with the idea that a lot of beautiful apparatus is necessary, and it isn't unless it fits the problem. So the thing to do is to develop the problem first, then get the equipment to solve that problem and get just as little as you can.

I had a very interesting case of that. The director of our research laboratory happened to be away one day, and I originated a little project for one of the boys to work out. No results came back on it and I asked them again about it. The man finally came to me and said in order to do the work he had to have $480 for apparatus. So I just thought I would find out about this fellow, and I asked him whether he thought it would be all right. "Certainly," he said, "I think that's all right."

"Well, supposing you had originated this thing yourself and you hadn't been associated with our laboratories, what would you have done about it?"

"In that case I would have started to work."

"Yes," I countered, "but you couldn't have had the $480 worth of equipment."

"I would have found some way to do it."

"Well," I said, "you are going to find out some way right now." And he came back about two days later laughing and said, "I only need about $46 worth of apparatus."

"There is no question but that you certainly need the piece of apparatus all right. And, incidentally, you have done more real, honest-to-goodness valuable thinking in the last 48 hours than you ever have before, because you have thought something like $420 worth."

So it isn't the apparatus that can be bought; it's the essential apparatus that is needed. But just to equip laboratories and do this and that and the other thing doesn't mean anything. But I can see why so many men voted for this shop, because that is a very nice way to appear busy, to tinker around and have an excuse for not doing something that ought to be done. The hardest thing in the world is to get a fellow to do the economically common sense thing, but he will never do it if he has an excuse for doing something else. We are just the greatest alibi artists in the world. I have always said that is the reason why so many people are temperamental. My notion about a temperamental person is that he is just a lazy fellow; he doesn't want to be bothered doing anything but what he likes to do. That is the question of being self-entertained. When anybody disturbs his perfect happiness and his self-entertainment, he gets angry and shows his temper.

Now I have a way of getting around that sort of thing which has worked quite satisfactorily. I will give you a specific illustration. I had one of these temperamental fellows one time and I put him out on the job. He had been out to a factory about two days on this particular thing—he was very good in that line of work—and he finally came back and said, "I can't do anything with that plant; those fellows are the dumbest lot I ever saw in my life."

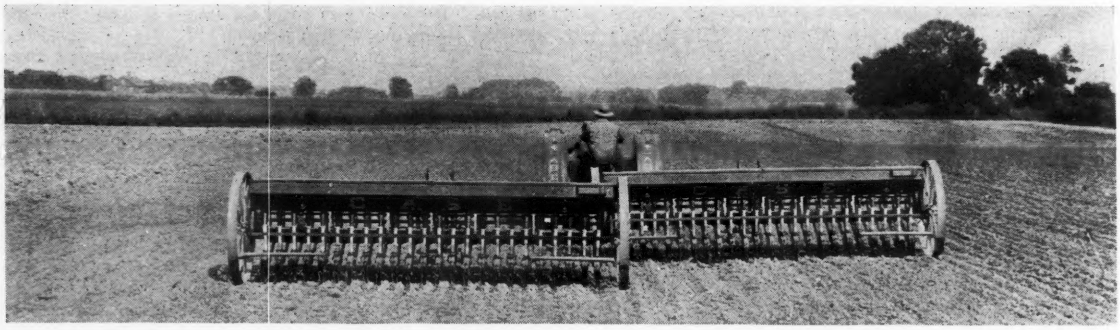
"Now look here," I said, "I'd question that statement because they have been one of the most successful divisions of the General Motors Corporation, and certainly from a manufacturing and an engineering standpoint you must go a long way to beat them because if they are dumb then you must have a very, very superior intelligence. That is important if it is true. Possibly this will interest you. About half an hour ago the works manager of the plant called up and said if you ever came inside it again he'd shoot you. Now you must go back there. I'm going to give you a letter of introduction to that manager, and you have got to go back there and solve that problem on the ground where it should be solved." Well, he went back—in fact, I had one of our boys take him back, as he wasn't going to go. And in about three months the works manager called up and said, "Would you have any objections if I hired this fellow?"

I said "No."

"Well, I would like to give him more money than you are giving him; that is all right if it's not too much?"

And the next conversation I had with that man was like this: He said, "I never realized there were so many good people in the world before." Originally they didn't speak exactly the same language, and, consequently, the minute they didn't understand each other, why my fellow just came to the conclusion the others were dumb. And then right away he went into the caste system of being above them, and he was just cast outside.

Now the next greatest difficulty outside of getting the proper equipment to do the laboratory and engineering work is to grow like everything else. First take the problem, get the apparatus, solve the problem, and then take some more problems, solve them and let the laboratory and equipment grow until you see what it has become. After it has grown and rambled around like a grapevine, then is the time to build nice buildings to increase the efficiency of the operation, and then thought can be given to the organization and buildings. If there is absolutely no place on earth to put it, build a shed somewhere to put it in. But don't make it look too much like a college building to start off with. In fact, I have spent the last



The first thing for a research man to do is to find out what he wants to solve. No one needs a laboratory to go out to his problem and get acquainted with it. After that it can be solved

The pure science research man has just two things to take into consideration—material and energy relationships. Industrial research problems involve two additional considerations—economics and psychology.

four or five years of my life trying to get a college building to look like a factory and have accomplished it finally. The net result was a saving of just one-half of the cost of the proposed building.

I don't know why it is but from a true engineering analysis standpoint piping ought to be accessible, because it is economical to have it accessible so a person can get at it. And desks ought to be so they can be moved around. I don't know why it is that in a college or university they have to hide the piping so when a leak occurs they have to tear the building down to fix it. It is beyond me completely. I don't see why I should be raised in an aesthetic atmosphere of no pipes, and then have to live with pipes all the rest of my life. I ought to get acquainted with them on equal terms right where they are. Consequently, I always insist that all piping in every laboratory be on the outside, and that all the partitions be so they can be moved, because this problem which we have today will be another kind of problem tomorrow. The whole arrangement may have to be torn down and moved around. The essentials are a space of some kind and some pipes to provide what you need.

The next thing is getting the fellows to analyze the pure science man. Engineering and research are the technical phases. And that brings up an important thing. We always hear discussed the difference between industrial research and pure science research. The pure science research has little respect for the so-called industrial research man. In fact, to the former he is a very, very low order of man.

I have analyzed this pure science man. There are just two things for him to take into consideration, his material and energy relationships. That is all he has to work with. The industrial research man is also a very important factor, if he is any good. He has to take into account the question of the economics of the situation and the psychology of the thing. Is the purchaser going to like the results of his work; is he going to pay enough money so it is profitable to do it?

And so the industrial research man has those four factors. The complications of doing a four-factor job are infinitely more complex than a two-factor job. We can't do that sort of job in the university laboratory and fit the problem to suit the case; we must do it in the industrial laboratory, and that is where we complicate the problem with limitations. Well, we can't help that; the problem is what it is. Most people spend half their lives trying to change the problem so it is something they can easily solve. It is just exactly like the doctor who came in to look at a patient. He finally gave him a dose of medicine. The fellow went into violent contortions. Another fellow said, "Heavens, he's worse." And the doctor said, "Oh, no, he isn't worse, he's just got fits now, and I know how to cure fits."

Now that is exactly what we do, spend most of our time trying to shape the problem around so it fits some particular patent medicine remedy we have. We see that in the maintenance end. In one city it will be spark plugs, in another it will be valves, in another it will be the carburetor—because in that particular city they happen to have an expert or school on carburetors or valves or something else. Another fellow is an expert on spark plugs and everything is spark plug trouble—"You must change spark plugs; that cures everything." On the west coast there is one kind of trouble and in New England another kind of trouble with the same machine doing the same kind of work.

Now the trouble isn't with the machine; it's with the patent medicine remedy that fellow is trying to apply to it—it's "fits" again, that's all.

Now every once in a while everybody says, "Well, now that is a very difficult problem—that is a very difficult problem." And so I have made our fellows, when they come to talk over difficult problems with me, sit down and analyze what is a difficult problem, because that is quite enlightening. The only thing a difficult problem is, it is one we don't know how to solve. So we are blaming our ignorance on the problem, just like the doctors do with the incurable diseases. The incurable diseases are the ones the doctors don't know how to cure, and they blame it on the diseases. The difficult problem is the one a person does not know how to solve and a very, very difficult problem is one he never heard of before. So we are all the time trying to shift the burden of proof over to the product.

The best illustration I have of that is as follows: A friend of mine in the steel business used to send to me little pieces of steel he had produced in an electric furnace. One day he sent me a particularly hard-boiled piece of steel. I was going past the machine shop and, stopping at the foreman's office, I said, "You take that piece of steel and drill out some chips and give them to the metallurgical department," because I had to leave the place. I knew they didn't have any apparatus for drilling it, but I didn't think any more about it until the next week. I dropped in and I said to the foreman, "You didn't forget about that piece of steel did you?"

He said, "No, I didn't forget about it, but you can't drill that stuff."

I said, "Why?"

"Well, it's too hard."

"Did you try a diamond drill?"

"No."

Well, we got a diamond drill and put a hole through the piece getting some chips. I said, "Did it ever occur to you the reason you failed the first time was because the drill was too soft, not because the steel was too hard?"

Now in industry in working with hard problems we are working with a lot of soft drills instead of hard problems. Now, as I say, a problem is what it is; it is not what we wish it to be. And that is why it is very difficult to get the fellows to do the problem; and that is why a laboratory isn't always necessary. The difficult part of any research work is getting the problem thoroughly dug out and laid out on the table so we can say, "There it is." An awful lot of money can be spent perfectly uselessly trying to solve something when we don't know what it is. That kind is never solved except by accident. But accidents don't happen often enough to pay to go into it as a regular business.

Now perhaps there is another phase of modern industry today which isn't receiving as much attention as it should, that is the thing called "change." We are living in a changing world. That can't be stopped. Everbody for centuries thought it was dangerous to make changes and, therefore, we fought the change and fought it and fought it until finally it had to be done at enormous expense under a lot of turbulence and one one thing or another. Finally the change is made and then we say, "Well, now, we've got that done we can stay put for a while."

The purpose of research in engineering is to enable agriculture and industry to keep in pace with the times by making necessary changes in a common sense, economic way

It is that point of view which has caused more trouble than anything else because nothing can stay put. We can't stop the calendar from going around, unless, doing the Einstein stuff, you travel with the velocity of light so the time couldn't go. If we could do that it would be all right. But just as long as we are going to live on this earth and have 365 or 366 days in a year and 24 hours a day, and new people are going to be born every year into it and old people die off, we are going to have change. It is a continuous process.

Now the fundamental basis of all this thing we call research in engineering is how to keep in pace with the times on a common sense economic basis, how to make in an economic way the changes that must be made and not in a haphazard way. I think a research department should be called "The Department of the Economic Change Men." That is what it really is. We have a procuring department for buying raw materials, we have a factory for fabricating them, a financial department, a sales department, and so the research department should be the department for the procuring of new ideas and the organization of them so they can pass as a material into your factory for the support and continuous development of an industry.

Now until people get that point of view, they are going to have a very, very unsatisfactory result with any kind of research they start. Sometimes the management is more to blame for the peculiarities of the research department than anything else. I don't know how it is out here in Moline but a lot of times the managers play golf, and they talk to some fellow who says, "I think the Diesel engine is going to be the coming thing." He comes home and says, "Boys, I think we must get on this Diesel engine business; just forget anything else." Or maybe it is this or that or a thousand and one other things that the manager makes a hobby of. He doesn't want to know the facts about the thing but tries to force it, with the net result that the best ideas usually get sidetracked.

A concern has to analyze research, to find out how it fits into the particular job, to find out what are the economics of it, because, after all, if it doesn't pay something or lay a foundation for new business, it is wrong, and it should be thrown completely out of the organization. And I say the red bank balance is nothing but the hisses of the community and the black bank balance is the applause of the community. If they like the product, they are willing to pay more than it costs to make it. That is all there is to it.

Finally, when it is going to be measured to find out whether the concern is going to be successful or not, it depends upon whether or not it has money to pay its bills and there is no other way to get around it. Now this added expenditure which is called research and engineering helps to outline the future policy so that a company will go from this position to a better position, so that it will better the products, better everything else which is fundamental and should be carried out. It is simply a side line entirely apart from the rest of the organization. A department with a lot of apparatus which is shown to visitors should be charged up to advertising.

Now this question of keeping step with the times is a very, very important one because we can't go ahead these days if we just run around loose. Things are too complicated, too many new things are being found out, so we have to go ahead and try to keep step with our business. We must do that. But the thing I want industry to do is to take research and make it an operating department of the industry, the same as any other department, instead of setting it aside. That is where most people make a great mistake and take the profits right out of the business itself.

Here is a very interesting thing. We have had this demonstrated a half dozen times. Let us start out directly to solve some production problem. It may look very, very simple. It looks as though it would be just this or that. We go down this road and don't get any place and try and try and try. And it is necessary sometimes to go to work and completely go back over the whole thing only to find we were headed in the wrong direction, 180 degrees from the direction in which the answer lay. And then when we get going in the right direction, things begin to unravel and unfold and the problem is solved. But that takes time.

Impatience has ruined more research projects than any other single thing I know of. It takes time and patience. It is very difficult for a man to do things against his experience. Regardless of what is known or what isn't known, the most difficult and dangerous thing to deal with in all these problems is past experience because it says, "You ought to do so and so." It restricts thinking. The first thought is "We can do that," which may be almost exactly opposite to what would be done. We can't orient ourselves in a minute. We have to work around it a while.

And if what I have just said is true, this ought to be true. We say it takes four years for any organization to re-orient itself to a new problem and, therefore, the problem must be solved about four years ahead of time when it can actually be put into production. So time is the most essential thing. And how to economically use the time is just as important in setting up a research program as the men who do the work.

It is not necessary to go out and get specially trained men. The most specially trained man needed in the research laboratory doesn't have to be a technical man at all. The most important thing in any research organization is to analyze out of the economic industrial situation what is the most important thing we would like to have solved. Now we make more mistakes in the world by hiring technical men and expect them to be economists and analyze our propositions and to pick out the right thing to do than in any other way. There is no trouble in hiring specific mechanics today or specific chemists. It is too much to expect the fellow who has no training in his college career dealing with economics, management, sales and all those things, to know the important reason for having a thing this way instead of some other way. Every once in a while we have fellows become very much offended when we put them on an elementary job when they think they have the ability to do a complicated job. Simply because it doesn't fit into the economic situation now he thinks he ought not have to go head and do it.

The whole thing is how to analyze the problem to uncover the limiting factors, because every industry would grow indefinitely if it didn't have something to stop it. Our business is all limited by something. What are the limiting factors? If one of the limiting factors is that there just aren't enough people to buy it, that is not a matter for research. If the factor is because the particular problem is outside the mechanical range and people can't pay for it, that is an ideal research problem. But the research man doesn't want to consider the matter of reducing the cost.

The next thing about the problem is the question of fitness--does this thing exactly fit the situation? Maybe it is theoretically correct, and maybe making it theoretically correct will make it cost $100. If we make it 95 per cent correct, it might cost $25.00. Thus we might find that last 5 per cent costing too much. So, what is the economic fitness and how can the thing be analyzed to get the results? Those are the problems that have caused a great deal of research to fail for the simple reason the men in the management do not recognize that the trained physicists and chemists may be perfectly wonderful in their particular line, but they haven't the ability to pick out what problem should be solved.

Now in the great business of agriculture with which we are all associated, we have perhaps the most fascinating and complete business in the world. We have the question of the machinery, which is one of the things with which we have to contend. We have the question of chemistry; we have a thousand and one things. I know of no industry in the world today which is going to have the great modifications in the next forty or fifty years which agriculture is going to have.

Just recently the Patent Office, I believe, passed a ruling it is going to grant patents on plants. That is a very significant thing, because it is possible today, with the things we are beginning to know through our chemistry, to make a plant grow to produce almost anything you want.

Now the patenting of a process by which you can make a plant do differently than what it does under the normal environment is very interesting; it is the first time I ever heard of it being done in the history of the world. You see all we have done previously is just to take plants as they are. We sowed this and that and the other thing and reaped whatever grew.

The plant is the connecting link between us and the sun. We have a driving mechanism from the sun down to the earth, just as if it was a great shaft rotating. Every bit of energy we have comes from the sun. Everything which is moved on earth is moved by the sun and nothing else. The plant is the thing which picks up that energy and converts water and carbon dioxide into a chemical compound. Plants have grown; they have developed in a normal environment, and we have them as they are. We don't farm so many acres of ground; we farm so many acres of sunshine. If we take a grain of corn and plant it, in about 90 days it will grow up so it will weigh about 2500 times the weight of the seed planted. About 94 per cent of that cornstalk didn't come out of the soil. In other words, if it is burned, the heat we get back from burning the cornstalk and the ear of corn is nothing more than energy collected from the sun. We shall get three of four per cent ash, and if we plant a grain again we can raise another stalk of corn. We can repeat this indefinitely because the material the plant takes out of the soil is only the machinery and tools by which the sun is able to fabricate the carbon dioxide and water into the necessary things.

So we are living from day to day. Some people say, "What are we going to do when gasoline runs out?" Well, we can grow our fuel. We can take that same stalk of corn and put it through a chemical process and make alcohol. And it is nothing more than a form of liquid sunshine, regardless of what they call it in Kentucky. That is simply a means of storing up solar energy until we want to use it.

Now in that particular thing we are just on the threshold. We really haven't thought about it yet. How can we secure more energy from the sun, and how can we catch it in the shape we want it caught? That is going to be the biggest factor, and it is going to have more to do in the next 100 years in changing the aspects of civilization than anything else we have ever done up to the present time. When we once find we can get this radiant energy to come down and can convert it into chemical form, when we can get the growing plant to function under a control system, I cannot, nor can anyone, predict what the possibilities are along that line.

So in your Society, together with the chemists, is being organized the greatest control group the world in the next 100 years is going to see. It is far more important than anything else, because it is going to get down to the vital factor—catching energy from the sun. That is the purpose of all the machinery—catching so many horsepower and keeping it until it is needed. On the desert we can't catch any because it is all gone by the next day. We can sleep under a blanket at night in the desert. Now that is all we are doing—catching the sun's rays and trapping them in the form in which it is chemically fire or food or this or that or the other thing.

Now, then, when we look at agricultural engineering from that standpoint, it is very, very young. It is old in terms of the fact that we have had to catch this energy and that we have had to raise crops; we have had to do this for years and years and years, but it hasn't changed much in principle. Today we are on the threshold of that modification, and are going into the second phase, the organic chemistry phase and the formation of organic compounds by radiation from the sun. No one can predict the possibilities of such things.

Engineers, Farmers and Tomorrow[1]

By Wheeler McMillen[2]

OUR nation seems to be well agreed that it faces no more important problem than that of increasing the prosperity of agriculture. Probably no one here will disagree when I say that the agricultural engineer and the scientist are more competent than any other agents to find the answers to this problem of agricultural prosperity.

The scientist's work is of primary importance. There is, however, a considerable gap between the announcements of the scientists' findings and their final application in agricultural production. The agricultural engineer's task in part is to build the bridge over that gap between the scientist and the profit-making farmer. This society may sometime have occasion to bring into its program the soil scientist, the agronomist, the plant pathologist and other agricultural specialists whose work can be made more effective by closer relationship with the engineer.

In his own realm and by his own right the agricultural engineer is destined to be foremost in the improvement of agricultural income. When one considers what extraordinary economies he has already introduced into production, this prediction seems conservative enough. No one here would be inclined to deny that the engineers' actual and potential contribution to profitable agricultural production is greater than that of any other agent.

The public, however, has not conferred the task of rehabilitating agriculture upon the agricultural engineer. It has delegated the job to quite another species, the politician.

You know, and I know, that the politician is not able to be of any such service to the permanent well-being of rural America as is the agricultural engineer. The public apparently accepts the politician in this case at his own evaluation. He has gotten the job away from the engineer primarily because he has gone out and told the world that he knows how to do it. He knows the road to the front page and to the microphone.

I am delighted to be able to pick one single and unique flaw in this group of modest and shrinking violets who compose the American Society of Agricultural Engineers. I refer to your tendency to hide your light under whatever bushel or barrel seems convenient for the purpose. If the people of the United States knew half as much about the competency of the agricultural engineering profession as it knows about the self-assertion of the politician, you would find yourselves celebrated far beyond the effusions that some of our more vociferous friends shower upon themselves

This is not a matter which you can adopt a resolution upon or refer to a committee or to your secretary. The agricultural engineer's assumption of his rightful place in the agricultural sunlight depends upon his own willingness to expose his own light.

I have advanced this point not alone by reason of my great esteem for this society and its membership, but because I feel that the advancement of the industry of agriculture is extremely dependent upon a broader understanding of the necessity for emphasis upon low cost of production. The continued prosperity of the millions engaged in agriculture depends primarily and fundamentally upon their ability to produce foods and fibers at a cost well below the price the world is willing to pay. The key to the job is in costs of production. I feel that greater conspicuousness for the engineer will be accompanied by greater publicity for this essential idea.

The engineer has already been a participant in upsetting the whole industry of American agriculture, not only in its business aspects but in its social structure. His motors and highways have erased old community boundaries; his new machines of production have greatly expanded the size of the ideal operating unit; he has made us trouble by creating a necessity for changing our ways. And now may we hope that he will proceed along his even way toward giving us a reasonable amount of order in place of the disorder he has provided.

May I offer here, one important and timely example, the so-called surplus, which will serve to illustrate this hope.

We have had some years of agitation and propaganda emphasizing the damage done to our agricultural income by the surplus production. This, of course, has followed a still longer period in which energies have been bent toward increasing and enlarging production. These efforts continue, while now we have the spectacle of a branch of the government of the United States, the Federal Farm Board, appealing to the farmers for restricted production of certain commodities in order that surpluses may not prejudice the success of new marketing plans.

Perhaps a reasonable case can be built up for the contention that if costs of production are lowered far enough by virtue of the efforts of the agricultural engineer and the scientist, there will be no surplus even though our total

[1]An address before the twenty-fourth annual meeting of the American Society of Agricultural Engineers, Moline, Ill., June, 1930.

[2]Associate editor, "The Country Home." Aff. Mem. A.S.A.E.

Far from being a delusion, the attainment of profitably low cost levels is already general enough to confirm its practicability as the soundest possible route to more satisfactory farm incomes

We need to rely less upon the capacity of the human stomach, and to insist upon more research to the end that the capacious maws of factories will demand more and more of the chemical raw materials which can be grown on the farm.

production of all crops and products might be very materially expanded.

The most widely accepted definition of surplus seems to be this: "A surplus is that portion of a commodity in excess of the quantity that can be sold at a fair profit to the average producer."

I leave it for you to decide whether, then, the following course of reasoning is sophistry, or sense, or some of each.

The entire quantity of non-perishable farm products and crops is eventually completely consumed, at some place and at some price. We have surpluses, not because the world can not consume all we grow, but because not enough people can buy at our price. Lower prices tend to promote consumption; higher prices obviously restrict consumption.

The surplus is, to repeat, the part that can not be sold at a profit to the average producer. If the average producer's costs are lowered to a level that will permit such prices as will promote ready consumption of the whole output, and still leave him a profit, there will be no surplus. Quantity is not the sole determining factor in the creation of surplus. Price and cost are equal, if not more, effective factors. We might well be able to grow just as much, or even more, without producing a surplus

The objective is to keep the cost line, by a satisfactory interval, below the line of price at which adequate consumptive power will be aroused. The proper remedy for surplus is not to grow less, but to produce cheaply.

To suggest moderation in prices might, before any other agricultural gathering than this, sound very much like a traitorous heresy. But prices at which the world will buy, accompanied by sufficiently lower costs, are an essential to the welfare of the farming industry. No business can prosper without customers. We can do comparatively little as an industry to adjust the purchasing power of our customers; we are obliged to adapt our production costs to their purchasing ability.

Were the possibility of farmers reducing their average production costs to generally profitable levels merely a chimerical fantasy, more excuse would exist for the widespread disposition to approach the farm problem solely in terms of increased prices. Far from being a delusion, the attainment of profitably low cost levels is already general enough to confirm its practicability as the soundest possible route to satisfactory farm incomes.

The surplus is, in one sense, an individual, rather than a national problem. That is to say, the individual farmer whose costs are lowered to a point where he is making a satisfactory profit has escaped the destructive effects of what we have called surplus. I would not insist that national or local overproduction of particular commodities may not occur. We are considering the whole volume of agricultural production, along with the possibilities of expanded markets, and with the interchangeability and substitution of crops.

A farmer who is saved from loss by higher prices, by the actions of a stabilization corporation or by natural means, is saved for that year only. He may have to be saved again another year. The farmer who is saved from loss by the adoption of low-cost methods of production is saved for a number of years; perhaps permanently.

The obvious method of decreasing costs is to enlarge yields. As long as the average yield of cotton is 156 pounds, of corn 28 bushels, of milk less than 3,000 pounds per cow, of eggs some 75 per hen, of potatoes 108 bushels, the opportunity for decreased cost per unit of output is too plain to need emphasis. Whatever the price, the advantage of larger output per acre and per individual farmer is definite and desirable.

Leaving out of consideration the idea of cutting costs by higher yields, which is primarily the task of scientist and educator, we have the more directly engineering method of reducing costs per acre, in addition to per unit of output.

This society has more than once devoted time to discussion of large-scale farming. Within the membership are numerous able exponents and practitioners of industrialized, large-scale agriculture. I join with them in the belief that wherever it is practicable, reorganization of the farming business into larger units is highly desirable, both economically and socially. We have heard presented before these meetings, and have seen printed in our excellent journal, figures indicating that the greatest economies in per acre costs are being obtained by the larger scale enterprises.

Without in any degree withdrawing from the position that larger farm units are desirable, may we not do well to face the fact that an overwhelming percentage of our agriculture is conducted in small units, and doubtless will continue for many years to be so conducted? Here lies the most serious obstacle to the dissolution of surpluses by low costs.

The 1925 census lists 6,371,640 farms in the United States. (Exactness would make some allowance in these figures for the census taker's habit of listing separate units of a single holding, small and suburban residential tracts, as distinct farms.) Only 63,328 contain more than 1,000 acres. Only 3 per cent of the total number exceeds 500 acres in area. Only 10 per cent of our farms have 260 or more acres. Indeed, only 18 per cent contain as many as 175 acres. We have nearly as many farms containing less than 20 acres as we have that exceed 175 acres.

I don't know just where the boundary line between large and small-scale farming is to be drawn. Under present conditions it seems that most economical production costs are to be obtained by large-scale operation, while ninety per cent of our farms—certainly all those of less than 260 acres—fall within the small-scale classification.

The most enthusiastic of us who advocate the efficiencies of large-scale farming will not venture to predict such a wholesale conversion to our point of view as to make nine-tenths of America's farms over into big units, either next year or in a decade. Most of these small farms, more than five millions of them, represent the limited capital possessions of individual owners, who are neither equipped to expand nor disposed to merge. We have to take them as they are.

We have, of course, a certain element that can hardly be classified as part of any industry. A considerable number, enumerated as farmers, are people who live on the land simply from disinclination to enter into any competitive struggle. The land affords to them merely a means of subsistence, rather than an occupation which they do not especially desire. Since most individuals of this class do not worry about themselves, I do not urge that we worry about them. Nor should we condemn them. We might even envy the philosophy that enables them to live happily with so little trouble. This group, however, must be relatively small.

Here, then, is a sounding challenge to the genius of the agricultural engineer. Having set set in motion the wheels of revolution, having developed efficient and profitable methods for the big operator, and thereby upset the equilibrium of competitive efficiency, can not this genius provide the little fellow with something like parity in opportunity for profit?

Many of us here believe there is ample evidence that

large-scale operation in agriculture has certain inherent advantages, although doubters may present themselves. Nevertheless, in the face of this overwhelming preponderance of small farm units, and the elements of permanence in this preponderance, the agencies of progress would seem obliged to undertake to find new routes to economical production for the small farmer. Positively, if we are going to slice off the surplus incubus by cutting deeply enough into costs, we must undertake to provide the little man with cutting tools that are in some proporion as effective as those already provided to the large operator.

I am not unmindful that much in the way of cost-cutting equipment already has been made available to the small farmer. Nor would I ignore difficulties that present themselves. A little machine, for instance, requires about as much material and labor for its wheels, its driver's seat, and various other necessary parts, as does a big machine, and thereby starts out with a higher overhead per potential unit of work. Perhaps the obstacles make the problem a litte more entertaining.

I have already indicated that only 18 per cent of United States farms have 175 or more acres. A still more impressive fact is that fully sixty per cent of our farms contain fewer than one hundred acres. Thus the great majority of farmers can benefit from the use of our larger and more efficient power and mechanical devices only by co-operative ownership, or by custom employment. A considerable advantage to manufacturer, dealer and farmer might be obtained if some one could work out satisfactory plans for promoting both cooperative ownership and custom use. Small fields and other factors will militate against attaining the highest efficiency, but the possibility of greater production economy surely warrants more extensive study of this phase. The sixty per cent who operate fewer than one hundred acres constitute a large potential market, as well as the largest human sector of our industry. The discovery of means to make available to the small unit farmers more of the advantages now benefitting only larger producers is an undertaking of unquestionable importance.

The small farmer may pare down his cost materially and yet not enjoy an adequate income. A wide margin between cost and price is in itself insufficient until the individual has large enough volume to bring his net earnings up to a satisfactory figure.

My old friend and neighbor, Ira C. Marshall, has year after year demonstrated his ability to grow more corn on ten acres than any other man has ever produced in the history of this planet. His cost per bushel is doubtless also unsurpassedly low, and since he sells much of his output for seed, his income per bushel is pleasantly high. Yet, if he grew but ten acres per year, his total net income would probably be too little to enable his fine sons and daughters to acquire the good college educations they are getting, or to permit him to buy the new home he has recently purchased.

I recall having enjoyed a discussion a few years ago with a farm management professor in the corn belt, who argued in behalf of small farms. We had before us the accounts of a considerable number of farmers in his state. He pointed out that the highest per acre net income was enjoyed by a man with 140 acres, a farm smaller than the nation's average. The figure was $35 per acre. He contrasted this with the largest farm on the list before us, 500 acres, which had produced a net per acre income that year of only $19, as evidence, in his opinion, of the superior efficiency of the smaller farm. Could you blame me for asking the professor whether he would prefer to have, as his own net income, $35 times 140, which is $4900, or $19 times 500, which equals $9500, a difference of $4600 in favor of the larger scale operation?

After all, the objective we seek is not net income per acre, but net income per individual farmer. Wherever the findings of the agricultural engineer make it possible or necessary either to lower this man's costs or to increase his volume of output, there a useful thing has been accomplished. There is no division of this society that can not find enormous opportunities for additional usefulness in endeavors to assist farmers to attain new records in low costs and in high outputs.

The members of the Power and Machinery Division have a distinguished record of achievement. Progress in their particular field is the foundation of our present revolution in agriculture. They have made the larger scale farm both possible and necessary. May we hope that they will find means to bring more of the benefits they have conferred upon agriculture within reach of those farmers whose location or circumstances decree continuance of small unit production.

Much of the improved attractiveness of rural life has grown out of developments that have accompanied achievements of the men in the Rural Electric Division. They have also contributed substantially to improved economies in production and to the possibility of greater output per individual worker. We all know that their future program contemplates new records of usefulness in both these fields.

I shall not be surprised to find that in the next few years the members of the Structures Division, as well as the others, will announce new conceptions that will serve materially to reduce both the fixed and current costs of farm production. The fixed costs incident to the use of farm buildings will bear additional investigation. In this field may be found an opportunity to discover means for materially reducing the costs of moving, handling, and storing materials, which are an unduly high proportion of the total costs of farm operation. Economically designed structures can help substantially in reducing the amount of moving and lifting now required.

Likewise, the costs of drainage present to the members of the Land Reclamation Division a field for continued effort. Drainage is usually a fixed overhead, once installed, but material reductions may be possible. Again, for a considerable number of small farms producing high-value products, such as vegetables, the additional control of production factors which might be obtained by cheap irrigation, overhead or otherwise, affords a line of most promising research.

The College Division touches upon all these problems, with facilities for continuous direct contact with large numbers of farmers. The advancement of agricultural engineering teaching, and the creation of public understanding of the agricultural engineer's importance, present opportunities here.

But it is not in my province to discuss the detailed work of the agricultural engineering profession. We are concerned, rather, with the broad fundamentals of both individual and national programs for the betterment of those who are engaged in agriculture.

We have here a nation capable of enormously greater production than we have yet seen. Perhaps sometime economic conditions will permit us to realize our potentialities in that direction. At the moment our problem is not one of enlarging national agricultural output, but of enlarging individual output. Of all the measures that have been proposed for preventing greater volume of production per individual from leading to national overproduction under present conditions, but a few can be effective. The low-cost man will usually be safe. We shall do well, however, to forestall having too many high-cost men by promoting sound policies for the utilization of land. We shall need to rely less upon the capacity of the human stomach, and to insist upon more research to the end that the capacious maws of factories making industrial products will demand more and more of the raw chemical materials we can grow on the farm.

Permanent prosperity for American agriculture cannot be built upon a program of restricting our production, and thereby relinquishing our markets to the farmers of other lands. Rather, our proper route to satisfactory incomes and comfortable standards of living for the individual farmers who are our agriculture, is by way of curtailed costs and not curtailed acres, and by way of expanded rather than restricted volume of output.

Progress of Agricultural Engineering Research, 1929[1]

By R. W. Trullinger[2]

RESEARCH in agricultural engineering has shown decided progress during the past year. While the total amount of work as indicated by the number of specific investigations has not shown any great increase, there has been decided improvement in the character of the investigations. A big feature of this has been the inauguration of individual studies of increasingly far-reaching importance, which fact considerably outweighs in significance the matter of mere amount of the work.

According to the records of the Office of Experiment Stations, 317 major projects of research and investigation are now in progress at forty of the state agricultural experiment stations. Of these, fifty-one are being supported wholly or in part on the Purnell fund, and five on the Adams fund. Thirty-six are being conducted in cooperation with the different bureaus of the U. S. Department of Agriculture, including the Bureaus of Public Roads, Agricultural Economics, Plant Industry, and the Forest Service.

The subject of machinery leads with 132 projects at 33 different agricultural experiment stations. Structures is second with 41 projects at 21 stations. There are 33 projects in irrigation at 13 stations, 24 projects in drainage at 12 stations, 32 projects in rural electrification at 18 stations, 21 projects in materials at 12 stations, 13 projects in sanitation at 9 stations, 11 projects in land clearing at 6 stations, and 10 projects in soil erosion at 9 stations.

MACHINERY

The investigational work in mechanical farm equipment has continued to grow and redevelop in a gradual and very healthy manner. The influence of the activities of the Advisory Council on Research in Mechanical Farm Equipment is still being felt in many quarters. The elimination of superficial and poorly directed investigations and the reorganization of general investigations into specific and fundamentally sound research studies have been going on in a sound and conservative manner.

Harvesters and Threshers. The 132 projects in the subject include 20 studies of harvesters and threshers at 14 stations. Studies of combines and combining practices especially have assumed considerable importance. These have advanced far enough to show that combining, when properly done, saves considerable power, time and labor. However, it presents several disadvantages, among the more important being the apparent necessity of providing means of artifically drying the grain, and efforts to correct this difficulty are being made by several of the experiment stations and by the U. S. Department of Agriculture. From the standpoint of labor economy the necessity of developing portable drying outfits seems apparent. From the standpoints of design and manufacture basic facts relating to the mechanism and requirements of the removal of moisture from grain are essential. Improper design and adjustment of cylinders and concaves such that the requirements of different kinds and conditions of grain are not adequately met appear also to offer important problems owing to the losses of grain involved. Grain losses back of the cutter bar have been found to be important also in some localities. The windrow pick-up method of handling the cut grain has been found to offer possibilities in several localities, and considerable progress has been made in the development of the bulk handling of the threshed grain. The economical disposal of straw is still an important problem.

The above combining problems call at this stage for studies of the requirements and mechanism of cutting, threshing, handling, and drying of grain. Power as well as grain is being wasted by the use of inefficient methods and equipment, and it is not enough to merely test equipment which is already available. Efforts must be made to determine what actually takes place when grain is properly cut and threshed and the basic requirements therefor, and to what extent and in what specific respects available equipment falls short of adequately performing these operations. It is only with a complete knowledge of the requirements and the specific inadequacies of the equipment that manufacturers can produce the right kind of grain harvesting and threshing machinery.

Similar conditions exist with reference to the development of potato harvesting equipment. Potato harvesters are being studied in this country and in Europe, and the investigations for some time have been centered on certain power and labor consuming details such as elevating, cleaning, and the like. Interesting results have been obtained at the Pennsylvania Agricultural Experiment Station and in Germany. In the latter studies considerable time has been devoted not only to elevating the potatoes but to

[1]Paper presented at the 24th annual meeting of the American Society of Agricultural Engineers at Moline, Illinois, June, 1930.

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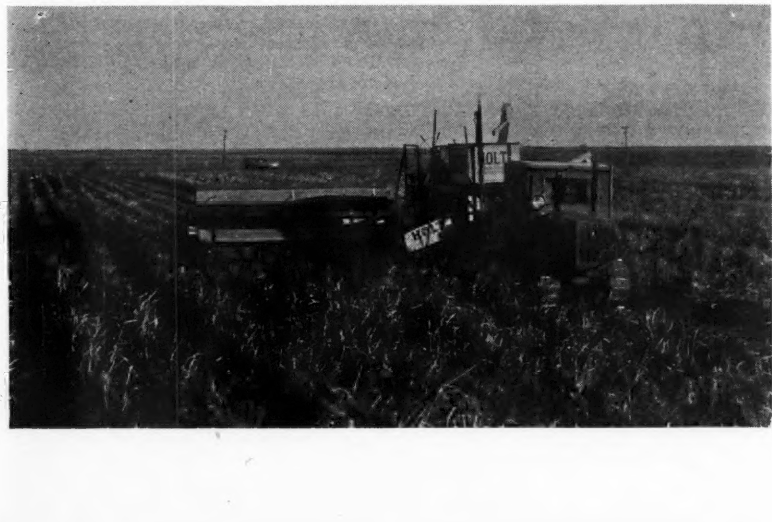


Combining problems call for studies of the requirements and mechanism of cutting, threshing, handling and drying of grain

Since agriculture utilizes so much power and such a large proportion of it is now mechanical in character, it would seem worth while for agricultural engineers to devote some time to the fuel problems of tractors and stationary engines as they relate to the requirements of specific types of agricultural performance. A more thorough knowledge of liquid fuels may possibly lead to greater economy in power utilization as well as to more satisfactory and flexible performance of traction machinery.

cleaning them. So far no type of sieve cleaner has been fully successful in separating heavy soil from potatoes, although in the lighter sandy soils good results have been obtained with horizontal wheel type sieves. It appears also that proper lubrication of these machines is offering quite a problem, the depreciation in oscillating plane sieve cleaners being especially high for this reason.

Progress is being made also in the efforts to develop corn and cotton harvesting methods and equipment which of necessity are gradually being concentrated on specific features of the equipment. For example, the corn harvesting studies at the South Dakota Agricultural Experiment Station are dealing primarily with the optimum diameter, length, speed, and angle of husking rolls. These studies, as well as those on grain and potatoes, also call for close cooperation with the field crop specialists concerned. The production of cotton which ripens uniformly, of corn with the ears at the proper height and of uniform height, and of uniformly ripening grain, for example, are important features of the development of power, time, and labor-saving methods of harvesting. The research agricultural engineer should give full consideration to the agronomic features of the problem in each case, therefore, in order that the solution to the specific problems of harvesting may occur at the most profitable medium point.

Power Requirements. The research program at the experiment stations includes 19 studies at 14 stations on the power requirements of different mechanical operations of the farm. Some of these are rather general power surveys, but several relate to the power requirements of specific operations involved in the production or processing of individual crops such as corn, cotton, potatoes, hay and the like. Such studies, when concerned with specific operations related to definite crops, serve an extremely useful preliminary purpose in showing the distribution of power utilization in the production of a crop, and at what points efforts can be made most profitably to reduce this consumption of power and labor by engineering manipulation.

Tractors and Tractor Economics. There are 12 projects relating to the engineering development of tractors at 9 experiment stations, and 4 projects relating to tractor economics at 4 experiment stations. The economic studies serve a very useful purpose in pointing to the inadequacies of available tractors for specific cropping operations from the standpoint of cost. The engineering studies which are, for the most part, being conducted in cooperation with field crop specialists are now narrowed down in most cases to the consideration of specific features such as traction, stability, steering, bearing wear and lubrication, carburetion, air cleaning, and the like. The California Agricultural Experiment Station reported further progress in the development of suitable break-pins for the hitches of tractor-drawn implements. The same station also found that the most satisfactory air cleaners for carburetors are the oily filter types. Progress also was reported in the studies of crankcase oil filters, it being found, for example, that filtration of the oil reduces engine wear considerably, and that carbon rather than other solid foreign matter in the oil limits the useful life of such filters. The Alabama Agricultural Experiment Station continued the study of the fundamental factors influencing the traction of wheel tractors, progress of considerable practical utility being made.

As pointed out in a previous paper[3] it seems that at this stage the research engineer should consider the tractor, not as one big problem, but as a combination of several problems each one of which will be subjected to a definite and limited study based upon a clarified vision of the problem, a sound technique, and a profound knowledge of the specific requirements of the agricultural power operations concerned.

Engine Fuels. As usual considerable investigational work has been in progress relating to the development of internal-combustion engine fuels for specific purposes. Most of this work is in progress in research institutions other than the state agricultural experiment stations, but it is of interest to agricultural engineers since its purpose in general is to reduce detonation and carbon deposition and to produce maximum power from liquid fuels as cheaply as possible. The results have shown that different conditions of carburetion, fuel composition, and gaseous explosion are required for varying conditions of service for optimum performance. Since agriculture utilizes so much power and such a large proportion of it is now mechanical in character, it would seem worth while for agricultural engineers to devote some time to the fuel problems of tractors and stationary engines as they relate to the requirements of specific types of agricultural performance. A more thorough knowledge of liquid fuels may possibly lead to greater economy in power utilization as well as to more satisfactory and flexible performance of traction machinery.

Dairy Machinery. Investigations in dairy machinery have assumed considerable importance in the experiment station programs during the past year or two, there being now 19 projects in operation at 11 stations. These relate to such important subjects as the refrigeration and otherwise processing of milk, cream, and other dairy products, cream separators, sterilization of dairy equipment, heating water for the dairy, and the like. Considerable progress has been made at the California, Alabama, New Hampshire, and Wisconsin agricultural experiment stations, for example, on several of these features. The use of exhaust steam and electricity for cleaning and pasteurizing, and the like, has developed considerably, and the use of solar heat for heating water has now advanced beyond the research stage.

The engineering problems of the dairy are numerous and complicated and naturally in most cases call for the cooperation of the dairy chemist and bacteriologist to establish the basic requirements essential in their solution.

Crop Drying Equipment. The program of research related to the development of methods and equipment for the artificial drying and curing of different crops has assumed considerable importance at the experiment stations, there now being 12 active projects at 10 stations. The U. S. Department of Agriculture is also investigating

[3]Organization of Research in the Adaptation of the General Purpose Tractor (AGRICULTURAL ENGINEERING Vol 11 (1930), No. 2, pp. 65-68.)

the drying of both hay and grain and is interested in hay curing from the standpoint of spontaneous combustion. The experiment station investigations relate primarily to grain and forage crop drying, and fruit and nut dehydration. Considerable so-called practical testing of dehyrating equipment has been done in the past, but the results obtained have not as a rule yielded the information needed to further perfect the methods and equipment. The tendency now is to study the mechanism of drying of hay and grain and how it may be controlled for the purpose of establishing the requirements of the drying procedure. For example, the Mississippi station is organizing a study of the movement of water from different kinds of hays under controlled conditions of temperature and moisture with the idea of learning something of the physiological mechanism of this process at different periods during growth and curing, and how it may be controlled by artificial means. This should provide a basis for developing the methods and equipment necessary to produce the desired results in terms of cured hay most effectively at least cost. It is planned to supplement the physiological, engineering, and chemical studies with feeding and digestion trials to complete the necessary information relating to basic requirements for drying. Fully controlled studies of this character are what are needed at this time to bring the design, manufacture, and operation of crop-drying apparatus down to a rational and economical basis.

Tillage Machinery and Draft of Machinery. There are 7 projects at 6 experiment stations related to the development of tillage machinery, and 7 projects at 7 experiment stations which deal with the draft of farm machinery, mainly tillage tools, under different conditions. Several European agricultural research institutions are engaged also in studies of a similar nature. In addition to the corn-borer control machinery investigations being conducted by the U. S. Department of Agriculture, at least one experiment station is engaged in a definite study of corn-borer control tillage machinery. Incidentally the U. S. Department of Agriculture also is engaged in a plow draft study in connection with the development of corn-borer control tillage methods.

In the majority of instances the studies of tillage tools now relate to rather specific problems. The Alabama station is continuing the study of the specific dynamic properties of soil which influence the elements of tillage implement design, and the California station is studying the dynamics of the tillage machines themselves. The draft studies, particularly those at the Iowa station and those being conducted in the corn-borer control work, are aimed at the reduction of the draft of specific tools to a minimum through engineering manipulation.

The wearing properties of tillage tools are receiving considerable study, there being evidence of the existence of certain relations between wear and friction with the soil. In this connection some success has been attained by plating tillage tools with various materials to reduce the wear, but so far this practice is suggestive rather than indicative as it does not appear to have been definitely associated with the physical principles of friction between soil particles and solutions and the metal surfaces of tillage tools. In connection with iron and steel corrosion tests in soils the U. S. Bureau of Standards has found a relation to exist between the ability of a soil to react chemically on iron with liberation of hydrogen and its total acidity as indicated by titration. This finding, together with the results of the physical studies at the Alabama and California stations suggest that the logical development of tillage tools which will scour properly and give the desired degree of tilth with a minimum of draft must be based primarily upon a knowledge of the physico-chemical relations of soils and soil solutions of different characters and compositions and the metal surfaces of the tools themselves. Simple field tests of a comparative nature are no longer adequate to yield the basic data needed by the designers and manufacturers of tillage tools. The problem must be solved on a sound fundamental basis for different soil types and the results interpreted in terms of tillage tool specifications which the manufacturer can use. Cooperation with soil technologists, field crop specialists and metallurgists seems imperative for success in this work. The number of researches now under way is sufficient evidence that only a thorough solution of the physical and chemical problems involved will meet the requirements of the situation.

Fertilizer and Seeding Machinery. In addition to the study of fertilizer machinery by the U. S. Department of Agriculture, 6 experiment stations have 7 projects in operation aimed at the development of fertilizer distributing machinery. The joint committee consisting of representatives of the National Fertilizer Association, the National Association of Farm Equipment Manufacturers, the American Society of Agricultural Engineers, the U. S. Department of Agriculture, and the state agricultural experiment stations relating to the study of fertilizer distribution has been quite active in stimulating sound studies in the subject.

The necessity for controlled studies with different soils and crops and different types of fertilizers has become evident. The aid of the laws of physics is being invoked quite freely in this work for the reason that they can no longer be ignored. A recent report emanating from the U. S. Department of Agriculture on factors affecting the drillability of fertilizers emphasizes this point. Proper fertilizer placement for different crops is also important and the study as a whole calls for the close cooperation of engineers, soil technologists, fertilizer chemists, and field crop specialists in order to secure the basic information needed by the designer and manufacturer of fertilizer distributing machinery.

The situation is similar with reference to seeding machinery, there being at least 6 projects active at as many experiment stations in the subject. For example, the problem of cotton planting in soils infected with wilt and other diseases and which form a thick crust after rainfall is leading the investigators into studies of the rupturing strength of soil crusts and the vertical pushing power of individual growing cotton plants in order to secure information as to the requirements of planting to insure a stand of cotton. Simple comparative field tests of planters do not give enough information. Studies made in cooperation with crop specialists and soil technologists are necessary to develop the fundamental re-

Dr. Nixon's researches in potato growing at Pennsylvania State College have shown that a good seedbed for potatoes can be prepared without plowing. He disks a heavy cover crop into the soil before planting. One thousand Pennsylvania farmers copy his methods

quirements of planting for each crop and soil so that the designer and manufacturer of planters can provide the necessary equipment without a great deal of preliminary and expensive "shooting in the dark."

Miscellaneous Machinery. There are several projects in operation at the experiment stations and elsewhere relating to belt-driven machines such as silage cutters, feed grinders, and the like, and in some instances relating to specific features of field machines such as power take-off devices, steering gear, and the like for tractors. In the majority of these instances the work has now narrowed down to a study of one or two important specific things, the obvious purpose being to deal in a technical manner with individual rather than collective problems.

This sensible procedure is resulting in sure progress which was not always obtained by superficial and general testing methods. The research program in mechanical farm equipment and its needs now seem to be clarified to a considerable extent. It is the obvious duty of research agencies to establish the basic requirements for the different farm machines. It is their further duty to determine if available machines in each case meet these basic requirements. If in any case available machines do not meet the basic requirements it is the final duty of the research agencies to establish in what specific respects they are deficient and the basic principles of their proper performance and necessary redevelopment in order to provide designers and manufacturers with the information essential to permit the production of efficient mechanical equipment by modern mass production methods.

STRUCTURES

The program of research in farm structures appears to be rather limited in scope. However, if the 13 projects in farm home sanitation and the 21 projects in materials of construction are included under structures, the program at the agricultural experiment stations reaches a total of 75 active projects at 28 experiment stations.

Ventilation of Animal Shelters. It appears that ventilation of animal shelters is the most important structures problem at the experiment stations at present, there being 14 active projects at 11 stations. These studies deal with the heating and ventilation of poultry houses, dairy and stock barns, and hog houses. Some progress was reported in these studies during the year, especially with reference to the ventilation of poultry houses. The Iowa and Nebraska stations, for example, appear to have found no correlation between humidity in poultry houses and winter production of eggs, but that large egg production and general health seems to accompany small temperature fluctuations. The California station pointed to the value of roof insulation in controlling temperatures in poultry houses and the New York (Cornell) station showed the value of open-front poultry houses with reference to egg production.

The investigation at the Iowa station on the air requirements of poultry as a basis for poultry house design while proceeding slowly is still to be considered the type of research undertaking which is really needed. The testing of different types of poultry houses and ventilation systems has been going on for years but has never fully yielded the basic information needed for the design of poultry houses to meet different conditions. A knowledge of the air, moisture, and temperature requirements of different breeds of poultry for maximum production is essential to the proper design of such structures. The securing of this basic data entails controlled studies made in cooperation with poultry specialists, animal pathologists, and biological chemists.

Dairy and Livestock Structures. There are 6 studies of dairy and livestock structures active at 3 experiment stations. These deal with ventilation and construction and in some instances are cooperative with animal nutrition and biological chemistry departments for the obvious purpose of securing basic data as to the physiological requirements of dairy and other livestock for housing conditions. Such cooperation seems essential to success in the development of such structures.

Crop Storages. Crop storages are receiving an increasing amount of attention in the experiment stations. It is being recognized that comparative tests of storages which will house several different crops are frequently almost useless for yielding basic data which can be used in design.

The tendency now is to study the storage requirements of individual crops such as potatoes, sweet potatoes, apples, beets, carrots, and the like. This is calling for close cooperation with plant physiologists and has resulted in the rather general finding that, physiologically, crops vary quite widely in their storage requirements. The factor of storage diseases complicates the situation and calls also for cooperation with the plant pathologist. Interesting and important information has been obtained regarding the influence of different conditions of storage on the prevalence of various storage diseases. Finally it has been found that type of storage may profoundly influence the nutritive quality of stored crops. This, therefore, calls for a measure of cooperation with the nutrition chemist before all the basic requirements for the storage of a particular crop are fully known.

Farm Home Sanitation. The 13 projects in this subject at the experiment stations deal with sewage disposal, heating and ventilation, and water supply. While considerable has been learned regarding the disposal of sewage from farm homes, there are still several unsolved problems which relate to the tendency toward the increased

In any case where available machines do not meet requirements it is the duty of research agencies to establish their deficiencies, basic principles of proper performance and the lines along which redevelopment must take place

industrialization of agriculture. Where farming becomes almost a community proposition the sewage disposal problem assumes the proportions of that of the small town as to size, but is likely to be considerably more complicated on acount of the complex nature of the sewage coming from dairies and other processing plants as well as from dwellings.

Water supply problems are always present and call for constant watchfulness. The study of these in connection with sewage disposal problems which are considered as related to soil and topographic conditions seems important, and cooperation with health officials sometimes expedites the work.

Home heating and ventilation has been extensively studied, especially by agencies other than the agricultural experiment stations, such as the state engineering experiment stations and the American Society of Heating and Ventilating Engineers. In this connection much work has been done on radiator design and on minimizing heat losses through proper insulation. Much data is now available from various research agencies relating to heat transfer through different types of construction which may be used in the design of residences, animal shelters, or crop storages.

Materials of Construction. The investigations of adobe and rammed earth as structural materials have continued at several of the experiment stations. In California the use of sun-dried brick, rammed earth, and poured earth appear to be the practical methods of using earth in the walls of farm buildings. The same general results appear to have been obtained elsewhere.

Investigational work has been continued at several experiment stations on the preservative treatment of fence posts, shingles and other structural features of farm buildings. While most of these are still service tests of long duration, the tendency now is to develop laboratory tests simulating service conditions and to subject treated timbers to them, thus securing results in a relatively short time. This procedure calls for cooperation with forest pathologists, entomologists and biological chemists who are familiar with the natures and activities of the different insects, fungi, and bacterial diseases which attack wooden structural members of farm buildings and fences under various conditions. Such cooperation should provide a relatively exact knowledge of the requirements to be met by preservative treatment of structural timbers and should make available standards by which the degree of effectiveness of preservative treatments can be measured. The American Wood Preservers Association, the American Forestry Association, and the Forest Products Laboratory of the U. S. Department of Agriculture are also contributing valuable information on this subject and the Forest Products Laboratory is conducting research which has contributed numerous basic principles of design of timber structures.

The existing program of research in farm structures as a whole does not appear to be very profound or comprehensive in scope. Quite evidently the appointment by the Secretary of Agriculture of an Advisory Council on Research in Farm Structures and of a director thereof to study and clarify the field of research offered was a wise and timely move. The field of farm structures seems bristling with important problems calling for solution, and it appears advisable to identify these, classify them with reference to their agricultural significance and cooperative contacts, and organize and prosecute projects of research where such are justified.

RECLAMATION

The program of research in land reclamation at the State agricultural experiment stations includes 33 projects in irrigation, 24 in drainage, 11 in land clearing, and 9 in soil erosion, or a total of 77 projects at 24 stations.

Irrigation. The study of water resources has assumed considerable proportions, there being 10 projects active at 8 experiment stations. The U. S. Geological Survey also has continued to contribute valuable information on a large scale relating to water supplies available for irrigation. The experiment station investigations in the subject deal with both surface and underground waters and seek to establish principles governing their occurrence, amount, and movements. For example, the Utah station has learned considerable regarding the manner of occurrence and movement of mountain snow waters which has aided in their conservation and control for irrigation.

Duty of water investigations continue at 4 experiment stations. However, these are no longer the conventional type of duty of water tests but are closely related to the more advanced studies, the purpose of which is to establish the principles governing economical and efficient irrigation practices of which there are 6 at 5 experiment stations. These studies as a rule are cooperative with plant physiology, the purpose being to secure information relating to the basic requirements of different crop plants for water to serve as a standard in the development of economical irrigation practices. They are also cooperative in several cases with soil technology, the purpose being to learn more of the principles governing the existence, movements, and factors of availability of water to crops in various soil types and how these may be controlled, and thus to provide a further basis for the development of economical practices in irrigation water utilization. The Idaho station especially has reported progress in this connection and has been able to derive a mathematical expression governing the flow of water in thin sheets in certain soils. Thus duty of water is approached from both the standpoints of how much water a crop plant actually needs and how much can be accomplished with a unit quantity of water in a particular soil. The Arkansas station has reported progress in determining the duty of water for rice in the state and the New Mexico, Arizona, and California stations have advanced the knowledge of the irrigation of grain, hay, cotton, fruit, and root crops considerably in this connection.

Drainage. The drainage investigations at the experiment stations are being narrowed down from the broad general demonstration type of field drainage experiment largely to studies of the principles of soil hydraulics governing the movement of water through soils under the influence of drainage equipment. The purpose is obviously to provide a sound basis for the design of drainage systems for different conditions of soil, crop, and climate. A similar tendency is noted in the drainage investigations in Europe, particularly in Germany and Sweden. Cooperative studies in soil technology and agricultural engineering are gradually yielding the principles of soil hydraulics needed to determine the size, depth, and spacing of drains in different soils, and the relations of these principles to the moisture and soil ventilation needs of different crop plants are being established.

It appears from the experience at research institutions in this country and abroad that permanent progress in the development of economical irrigation and drainage practices depends largely upon the results of research which fully considers the physiological requirements of the crops and the technological requirements of different soils, as well as the hydraulic engineering principles governing the actual mechanical practices of water application to and removal from soil.

Land Clearing. Land clearing investigations are active at 6 experiment stations. They deal primarily with stone, stump, and brush removal by various means and naturally have strong economic features. Land clearing is at best a costly procedure and the problem at this time seems to be to determine how the many different available clearing methods may be adapted to different local conditions with the least cost. Considerable progress has been made in various localities here and abroad, especially where the investigations have been truly engineering in character, and much data are now available on the lifting and shatter-

A recent study of the programs of agricultural research at the experiment stations revealed a large number of instances in which electricity is or may be made to play an important part in the development of agricultural practices

ing power of different explosives, for example, and on the relative efficiency of several different mechanical clearing devices in terms of the resistance of stumps, roots, stones, and the like, to removal.

Soil Erosion. While the experiment stations have been interested in investigations of soil erosion for several years, the U. S. Department of Agriculture recently took the lead in this work. A special appropriation has made it possible to set up soil erosion experimental fields in various parts of the country where erosion is a problem. Ten agricultural experiment stations also are engaged in studies of soil erosion, some of this work being in cooperation with the federal department.

The experiment station program in soil erosion has developed considerably during recent years. The work now calls for cooperation between engineers, soil technologists and field crop specialists in most instances. The purpose is to study the erosive tendencies of different soil types under different cropping and climatic conditions to learn what are the important factors in erosion and how they may be controlled by artificial means or by the manipulation of natural processes. The conservation of runoff water, particularly in regions where periodic drouths offer a problem, is also an important consideration.

The necessity of studying the factors governing storm runoff and soil erosion under controlled conditions is reflected in the fact that some of the experiment stations are now even carrying features of the work into the laboratory in order to isolate soil factors responsible for these losses. Controlled erosion plats of different soil types with varying slopes and crop covers and equipped with catch basins to catch the eroded soil and runoff water have already yielded important information. Laboratory studies have added further to this information so that a grist of basic facts is now becoming available for use in the design of runoff and erosion prevention measures.

On the whole land reclamation including irrigation, drainage, land clearing, and soil erosion and storm runoff prevention is one of the oldest branches of agricultural engineering from the standpoint of research and investigation. In a way, however, it is still in its infancy and is bristling with problems of engineering hydraulics, soil technology and dynamics, and engineering mechanics which need fundamental solution. The tendency now is in that direction and it seems desirable that agricultural engineers interested in the fundamental development of land reclamation practices plan to direct their energies toward the permanent solution of some of the important specific problems involved.

RURAL ELECTRIFICATION

The 32 projects in rural electrification at the agricultural experiment stations are rather widely distributed among 17 stations. The investigational work in the subject has been rather slow in getting a foothold in the experiment stations largely for the reason that up until recently a considerable proportion of that active has been financed and conducted by state committees working in conjunction with the National Committee on the Relation of Electricity to Agriculture. Another reason was the fact that when the movement started there was a wealth of information which was susceptible of immediate practical application, and such problems as were encountered were largely of a practical rather than a fundamental character.

However, the Committee on the Relation of Electricity to Agriculture has been one of the first agencies to recognize the fact that the initial supply of practical information relating to the use of electricity in agricultural practices, while relatively large, is limited and not sufficient to bring about general rural electrification. That committee pointed out the necessity of ultimately developing enough new uses of electricity in farming to make rural electrification wholly worth while for all concerned.

It is in this connection that the experiment station program in rural electrification has undergone a gradual but comprehensive development. While the program in the subject itself numbers only 32 projects, a recent study of the programs of agricultural research at the experiment stations revealed a large number of instances in which electricity is or may be made to play an important part in the development of agricultural practices. This feature has been covered in a recent report of the director of research of the Committee on the Relation of Electricity to Agriculture and will not be repeated here.

Suffice to say, however, that in almost every branch of agriculture opportunities are offered for new uses of electricity. Each instance of this character calls for individual fundamental study in cooperation with the agricultural specialists concerned. Crop and dairy products processing, disease and insect control, animal nutrition, and like practices offer opportunities to profitably build up the rural electric load in addition to numerous direct mechanical applications. It seems important that each individual problem be indentified and separated for specific study, and that it not be forgotten that the designers and manufacturers of equipment must have information relating to basic facts and requirements.

CONCLUSION

The above discussion suggests that research in agricultural engineering, while not yet of startling proportions or quality, is assuming an air of stability and experiencing a gradual healthy growth which speaks well for those engaged in the promotion and prosecution of the work. The importance of preliminary clarification of a field of research is evident in agricultural engineering, especially where it leads to the identification of important lines of inquiry and stimulates the fundamental study of the individual problems involved. The necessity for cooperation with the agricultural sciences concerned and with other collateral sciences is also emphasized and finally the entire discussion points to the fact that a highly trained research personnel is essential to the success of the work. The importance of being fully prepared to immediately undertake research in agricultural engineering in case facilities therefor become available cannot be overestimated at this time.

The Effect of a Rapidly Changing Environment on Crop History

By Walter W. Weir[1]

THE crops grown in any community reflect the influences of an economic environment and changes in this environment will, given sufficient time, result in a change in the use of the land[2] and in the crops which are grown on it. Changes in the marketability of one crop as compared to another, changes in the soil, either for good or bad, which make it more profitable to grow one crop than another, changes in the social set-up of the community with its accompanying local improvements, conveniences and methods of living and changes in land values, taxes, local assessments and operating expenses which usually follow active social changes may all be considered as affecting the economic environment.

History of Area. The Newhope Drainage District, comprising 3565 acres, in Orange County California, located on the west side of the Santa Ana River opposite the city of Santa Ana, has experienced all of these changes within the past fifteen years. This area was chosen for study because of its political entity and the fact that the productiveness of the soil has been improved by artificial drainage. The drainage is probably the only factor in which this area differs from many others which might have been selected in southern California. The drainage system was completed in 1924, and although full advantage of this may not yet be felt, it is believed that sufficient time has elapsed to indicate a trend in crop adjustment to the improved conditions. A crop survey and map, including what is now the Newhope Drainage District was made in 1916 in connection with the field work on a soil survey[3] which covered most of Orange County. The 1916 crop map of the area under consideration is reproduced in condensed form in Fig. 1.

[1]Associate drainage engineer, University of California. Mem. A.S.A.E.

[2]Cosby, S. W. Utilization of the Soils in the Gilory region, Hilgardia 1:18, May, 1926.

[3]Soil Survey of the Anaheim Area, California, Field Operations, Bureau of Soils, 1916.

About the beginning of the present decade there was a tremendous agricultural and industrial development and increase in population in the more desirable sections of southern California. The area tributary to Santa Ana was not without its share of this development. The increase in land values, public improvements and other social and economic adjustments which accompanied or followed this development made it necessary that the area now in the Newhope Drainage District enter into the production of crops which would give larger returns than were being secured from grain and sugar beets. The grain and sugar beet acreages were rapidly replaced by alfalfa, oranges, walnuts and truck or market garden crops. It was soon found that poor drainage and alkali accumulations in the soil did not permit the growing of these higher valued crops to their fullest perfection. Irrigation, which was not practiced to any considerable extent when only annual crops were grown, was now being more extensively used, thus increasing the necessity for adequate drainage.

Between 1916 and 1924 there was considerable activity in property for residential purposes, and much of the land adjacent to the principal highways was subdivided into building lots. This land, as well as other property held for speculative purposes, was taken from what might be termed the cultivable area of the district.

In December 1924, before the drainage system had been completed long enough to influence the agriculture of the area, a second crop survey and map were made. A condensed form of this crop map is shown in Fig. 2.

Since 1924 there has been a decided change for the better in drainage conditions, and at the present time poor drainage can hardly be considered as a factor influencing the kind of crops to be grown. In 1925 the west levee of the Santa Ana River broke at a point about ½ mile north of the southern end of the district, causing the inundation of several hundred acres of land and doing some damage to the drainage system. Both the levee and the drainage system were immediately repaired, but the

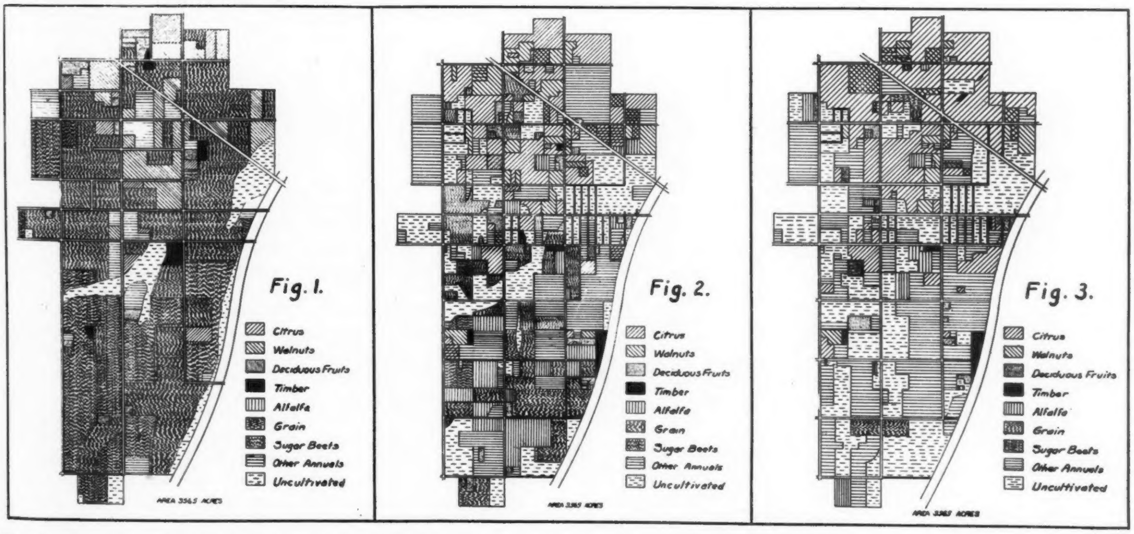


Fig. 1. Crop map of the Newhope Drainage District, Orange County, California, in 1916. Fig. 2. Crop map of the same district in 1924. Fig. 3. The 1929 crop map of the Newhope District

receding waters left a heavy deposit of sand over a number of alfalfa fields injuring them to the extent that they have not yet all been brought back into production. A third crop survey and map was made in December 1929. The map in condensed form is shown in Fig. 3.

Analysis of Crop Records. Table I gives in much more detail than can be shown on the maps the use which was made of the land in the district in the years 1916, 1924 and 1929, and the per cent of the total area devoted to each crop. The 1916 crop survey did not record any areas on which two or more crops were growing. There may not have been any such areas at that time, but in 1924 there were 140 acres and in 1929 there were 113 acres intercropped. These surveys were made at a time of the year when double cropping (one crop following another the same year after a complete removal of the first) as distinguished from intercropping, could not be readily determined by observation. Only such crops are indicated as were actually on the land or which could be identified from the stubble or remains left in the field.

Table II shows the land uses grouped under nine headings and the per cent of the area occupied by each. This is the same condensed grouping as was used on the maps shown in Figs. 1, 2 and 3.

Use of Land in 1916. It may be observed from Fig. 1 and from Table I that the farming operations as they were conducted in 1916 were of the type usually associated with large holdings of comparatively cheap land in strictly rural communities. More than 71 per cent of the area was planted to grain and sugar beets. There were at that time 180 acres or about 5 per cent of the district in walnuts, 164 acres or 4.6 per cent in oranges, and 333 acres or 9.4 per cent uncultivated[4]. Truck crops, which included potatoes, corn and peppers, if any were grown, totaled 243 acres or 6.8 per cent of the area in 1916.

Use of Land in 1924. Within the brief period of eight years between 1916 and 1924, there occurred many changes in the use to which land in this district was put. Subdivision into building lots took about 72 acres from the tillable area and factors directly or indirectly related to an active real estate market resulted in a considerable additional acreage not being farmed. Including about 219 acres occupied by roads, there was a total of 940 acres, or more than 26 per of the district not farmed in 1924.

During this period much additional irrigation water was obtained from wells; thus crops requiring more water than can be supplied directly by rainfall were planted in increasing amounts. In 1924 there were 266 acres of alfalfa occupying 7.5 per cent of the district.

Citrus plantings increased to 581 acres, or 16 per cent of the area (565 acres of oranges and 16 acres of lemons and grapefruit). This includes 112 acres which were interplanted, 49 acres of which were with walnuts. Between 1916 and 1924 the walnut acreage was increased by 90 acres, making a total of 271 acres or 7.6 per cent of the area. Sixty-four acres of walnuts were interplanted.

The grain and grain-hay acreage dropped during these eight years to 584 acres, or 16.4 per cent of the district. This is only about one-third of the former planting. Sugar beets show an even greater decline from 1080 acres, or 30.3 per cent of the area in 1916, to 63 acres, or 1.8 per cent of the area in 1924. Other annual crops, such as vegetables, beans and market garden products classified as truck in this survey, increased from 243 acres to 389 acres. By including with the truck crops 295 acres of peppers, 166 acres of corn, and 47 acres of potatoes, there was a total of 887 acres, or 25 per cent of the district in annuals exclusive of grain and beets.

Use of Land in 1929. In 1929 there were 1351 acres, or 38 per cent of the district untilled. This increase of more than 400 acres over the 1924 figures cannot be fully accounted for by the damage caused by the break in the levee, this being the only disturbing element of importance occurring in this period.

Only 2.5 per cent of the district, represented by 88 acres, were in grain in 1929, as compared to 584 acres in 1924, and 1470 acres in 1916. Some of the grain land may have remained uncultivated in 1929 as a result of a very dry winter. Sugar beets, which at one time occupied more than one-third of the district, were grown on one 10-acre field in 1929.

The orange acreage increased from 581 in 1924 to 916 in 1929, when 25.7 per cent of the district was so planted. Ninety-two acres of the oranges were interplanted with walnuts and ten acres with grapefruit. Although the oranges are planted very largely on the heavier soils at the north end of the district, there has been a recent tendency to extend the planting southward and at the present time there are young groves of considerable size well into the southern half of the district.

Walnuts, on the other hand, have decreased in acreage since 1924 and now with 187 acres are only slightly in excess of the 1916 planting. The change from walnuts to oranges is further shown in the fact that 92 acres, or

Table I.* Area of Each Crop Grown in the Newhope Drainage District for the Years 1916, 1924 and 1929

Crop	Map symbol	1916	1924	1929
Alfalfa	A	0	266	88
Grapefruit	B	0	11(1)	11(1)
Corn	C	0	166(1)	87
Apricots	D	46	5(2)	5(2)
Timber	E	30	21	20
Mixed deciduous (3)	F	3	14	12
Grain and hay	G	1470(4)	584	88
Berries	H	4	10	26(5)
Grapes	I	0	18(1)	7(1)
Peaches	J	2	12(1)	1
Sugar beets	K	1080	63	10
Lemons	L	0	5	5
Apples	M	10	23	11
Oranges	O	164	565(1)	850(1)
Peppers	P	0	295(1)	150
Potatoes	S	0	47	16
Truck (6)	V	243	389(1)	753
Walnuts	W	180	271(1)	187(1)
Uncultivated (7)	X	333	649	960
Uncultivated subdivision (8)	Y	0	72	172(10)
Uncultivated roads	Z	0(9)	219	219
Total		3565	3705(11)	3678(12)
Intercropped (13)	OB		10	10
	OP		9	
	OV		8	
	OC		23	
	OH		1	
	OJ		3	
	OI		9	
	OW		40	92
	WOP		9	
	WD		5	5
	WP		10	
	WC		4	
	FH		2	2
	FHI		4	4

* 1916 crop survey made in early spring; 1924 and 1929 crop survey made in late fall.
(1) Includes areas of this crop and some other crop in amount indicated under intercropped.
(2) Entire area intercropped with walnuts.
(3) Various undifferentiated deciduous fruits
(4) Includes some land which was fallow at time of mapping.
(5) 1929 area includes about 15 acres of strawberries
(6) Includes vegetables, market gardens, lima beans, etc.
(7) Includes all uncultivated land not in subdivision or roads.
(8) Subdivided and closely settled areas, not generally susceptible to cultivation.
(9) In 1916 roads were included in cropped areas.
(10) Includes nearly 100 acres in golf course.
(11) Includes 140 acres intercropped.
(12) Includes 113 acres intercropped.
(13) Two or more crops growing on same land.

Table II. Area of Each Crop Group and Percentage of the Distfict Occupied by the Group for the years 1916, 1924 and 1929

	1916		1924		1929	
	Acres	Per cent	Acres	Per cent	Acres	Per cent
Alfalfa	000	0.0	266	7.5	88	2.5
Citrus	164	4.6	581	16.3	916	25.7
Walnuts	180	5.0	271	7.6	187	5.2
Misc. fruits (1)	66	1.8	82	2.3	62	1.7
Annuals (2)	242	6.8	887	24.8	956	26.8
Grain	1470	41.3	584	16.4	88	2.5
Uncultivated	333	9.4	940	26.4	1351	38.0
Timber	30	0.8	21	0.6	20	0.6
Beets	1080	30.3	63	1.8	10	0.3
Total	3565	100.0	3705	103.7(3)	3678	103.3(3)

(1) Includes grapes, berries and all deciduous fruits except walnuts.
(2) Includes all annual crops except grain and sugar beets.
(3) Per cent based on 3565 acres in district.

[4]In 1916 the roads were not deducted from the cultivated area as was done on the two later surveys.

50 per cent of the total walnut acreage, is interplanted to oranges, whereas, in 1924, only 15 per cent was so planted.

There has been a general tendency to increase the orange acreage and decrease the walnut acreage in other parts of Orange County. There have been practically no new walnut plantings in the county for several years.

Market gardening and truck have also increased until in 1929 there were 956 acres of these annuals. This represents 26.8 per cent of the area under consideration. Of this acreage 150 acres were in peppers, which is only one-half of the area in this crop in 1924. These crops now very largely occupy the land in the southern half of the district, which in 1916 was in grain.

Miscellaneous deciduous fruits, such as apples, peaches and apricots, together with grapes and bush berries, have never been of importance in this district, nor in fact in any part of the county. The area of strawberries is small and fluctuates somewhat from time to time. Small eucalyptus groves are found in widely scattered parts of the district, most of which were planted prior to the first crop survey.

SUMMARY

The Newhope Drainage District has, since 1916, passed from an area of extensive agriculture in which more than 71 per cent of the area was devoted to grain and sugar beets, to one in which intensive agriculture and specialized crops requiring high capital investment and operating costs predominate. This change has been brought about by an economic condition which has accompanied a rapid increase in population, improvement in markets, transportation, and general living conditions in this and surrounding communities, and by an improvement in the drainage and alkali condition of the land itself.

With changes such as these, which should make for a better and more productive use of land, it seems somewhat paradoxical that there has been an increase in the uncultivated area from 9.4 per cent in 1916 to 26.4 per cent in 1924, and 38 per cent in 1929.

There has been a marked increase in the number of oranges planted within the last few years with no new walnut plantings. About half of the remaining walnuts are now interplanted with oranges, and if the present trend continues, these walnuts will be removed when the oranges come into bearing.

The area planted to truck crops and vegetables has increased, although peppers which may be included under this general heading, have during the last five years been decreased by 50 per cent.

Walnuts, oranges and truck crops now occupy 58 per cent of the area of the district and 93 per cent of the cropped area in the district.

Stock Tank and Poultry Water Heaters

By Hobart Beresford[1]

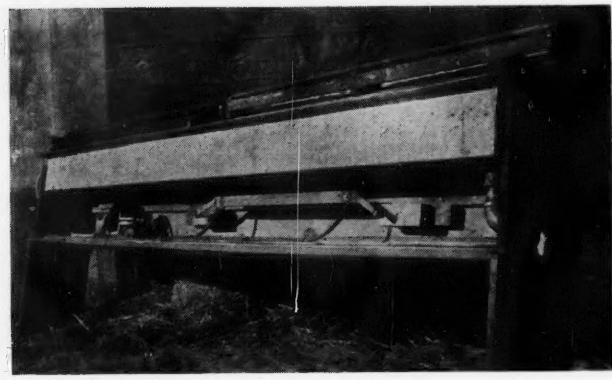
THE heating of stock and poultry drinking water during the winter months is considered a necessity especially for fattening lambs, dairy cattle and high producing flocks. There are many simple devices used for poultry water heating. The small electric lamp inserted in a tin can, which has been soldered over a cut-out section of the bottom of the drinking water pail has been used. The small immersion type heater and the small electric plate or stove type heater which just fits the bottom of a drinking water pail have all been found satisfactory. One of the outstanding applications of electricity to poultry water heating has been made by Loy H. Lee, of Middleton, Idaho. Mr. Lee used a galvanized trough 8 feet long, 8 inches wide and 6 inches deep with a 2-inch flange around the top edge. One 345-watt space heater controlled by means of a thermostat that had been discarded for incubator use was placed in an airtight box underneath the trough, which just filled the upper part of the box. An overflow drain is provided in one end of the trough by means of a screw-in pipe, which when removed permits easy cleaning. A great deal of time and labor can be saved by providing the water supply through an automatic float valve.

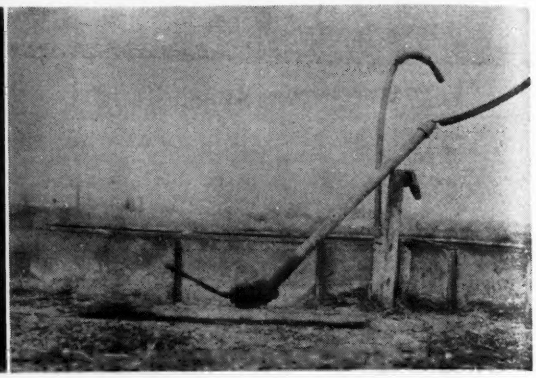
With the idea in mind that the temperature at which the greatest amount of water would be consumed by the birds would be the most satisfactory from the standpoint of egg production, experiments have been conducted at the Idaho Agricultural Experiment Station to determine at which temperature the most water would be consumed. It was found that for the first few days more water was used at 50 degrees (Fahrenheit) than when the trough was maintained at 40 degrees. However, when the birds became accustomed to the warm water the consumption dropped back to the same amount consumed at the lower temperature. For this reason it was decided that there was little advantage in maintaining the drinking water at above 40 degrees, inasmuch as there was no apparent effect on the egg production from the flocks. However, a comparison of the pens receiving the 40 to 50-degree water, and the pens receiving water in which ice was allowed to form, gave an egg production record decidely in favor of the pens receiving the warm drinking water.

Where the drinking water was maintained at between 40 to 50 degrees an average of 15 gallons of water was used per day. This was approximately twenty per cent more than the same flock of 800 pullets required when the water was allowed to remain at a freezing temperature. During the days that the temperature of the poultry house averaged 18 degrees, the heating element was required to operate twenty hours out of every twenty-four in order to keep the drinking water at the required temperature. The average energy consumption for the thirty-day period was 3 kilowatt-hours per day. During the coldest weather (room temperature of 18 degrees) a maximum of 6 kilowatt-hours per day was used. The advantage of the thermostatic control, as used in connection with this poultry water heater is that the temperature of the drinking water never exceeds 50 degrees even though the water in the trough is lowered to within an inch or less of the bottom. This is not the case when the small stove type heater is used, for as the amount of the water decreases, the temperature rises until rapid evaporation occurs and there is danger of having the drinking water too warm. If the humidity in the poultry house is increased as a result of the drinking water being maintained at too high a temperature the litter is likely to become damp and frosty conditions result. The disadvantage of the thermostat is the additional expense which makes its use impractical except on the large watering troughs. For the small pans or pails, the immersion or clamp-on heaters are more convenient. If these heaters are to be used in connection with insulated pails or troughs a one hundred-watt element will prove satisfactory for maintaining four to five gallons of water at a temperature increase over the atmosphere of approximately 40 degrees. This means that for very cold weather, less water can be handled by a given heating element if the 40 to 50-degree range is to be maintained.

An early application of stock tank water heating by means of electrical equipment occurred on the Aberdeen substation of the Agricultural Experiment Station of the University of Idaho. A. E. McClymonds, superintendent

[1]Professor of agricultural engineering, University of Idaho. Assoc. Mem. A.S.A.E.





(Left) An electrically heated poultry water trough with box side removed, showing wiring and construction details. (Right) The electric stock tank water heater used at the Aberdeen substation farm

of the substation farm, reports that the first installation was made in 1925 with a 750-watt immersion type heater. This heater was used in a 250-gallon galvanized stock tank for heating between 100 and 125 gallons per day in the fattening lamb pens during the winter months. The accompanying photograph shows the method used by Mr. McClymonds for taking care of the wiring and making the electrical connections waterproof. A total of twelve month's records are available for this installation. The 750-watt element was used two years after which, due to a defect in the element, it was replaced by a 1000-watt unit. Mr. McClymonds favors the use of the 1000-watt heater instead of the 750-watt due to the fact that the water would heat more quickly and that there would be less likelihood of leaving the heater turned on longer than was necessary.

The first three months period that the 750-watt element was used the energy consumption averaged 90.7 kilowatt-hours per month, with a minimum energy requirement of ten and a maximum of 137 kilowatt-hours. During the 1926-27 season the heater was used two months, averaging 244 kilowatt-hours per month for the period. During 1927-28 the 1000-watt heater was in service four months with an average energy consumption of 279 kilowatt-hours per month. During 1928-29 the complete seasonal records are not available, however, for the first three months of the period the energy consumption averaged 401 kilowatt-hours per month. For the 12 months' record of this stock tank water heater installation, the average energy consumption per month has been 256.75 kilowatt-hours during which time it is estimated that 40,000 gallons of water has been kept well above the freezing temperature.

The water tank in which this heater was used supplied the lamb feeding unit on the experiment station farm, and in regard to the satisfaction secured from the service rendered by the equipment Mr. McClymonds says, "I think it is a very successful method of heating water and the lambs certainly appreciate the warm water; in addition it also saves a lot of chopping of ice which is necessary where no water heater is used."

In installing an electrical stock tank installation as recommended by the Department of Agricultural Engineering, University of Idaho, due to the fact that the heater used is of the immersion type, certain precautions must be observed in order to prevent the electrical circuit coming into contact with the drinking water. If this condition should occur we would have a short-circuit with the water in the tank and the ground. Livestock attempting to drink water under these conditions would be severely shocked, if not electrocuted. However, if the following precautions are used in making the installations there is very little danger.

The wires leading from the installation to the water heater circuit should be at least 8 feet in the clear at the tank unless the feed wires can be led in along the wall of a protecting building. Drip loops in the wires and a waterproof cap should be provided on the top end of the half-inch galvanized pipe. Where the stock tank is located in the open, a post should be set at the end of the tank for supporting the conduit which may be fastened to the post by means of pipe straps.

The bottom end of the conduit pipe is bent at right angles in order that the heater assembly may lie flat on the tank bottom. A two-inch to a half-inch galvanized reducing coupling is used to attach the heater element assembly to the conduit. A two-inch to a one-inch flush bushing is reversed, tapped on the inside and the head section of the bushing cut off with a hack saw. This will permit the thermal head of the heater to be screwed through the bushing and also into a 1½-inch to one-inch bushing to which is screwed the 1½-inch cross. A length of 1½-inch pipe sufficient to clear the element is added to the cross, and an elbow on the end of the pipe completes the assembly.

With this arrangement the cold water is admitted at the thermal head of the heater through the side openings of the cross, and is expelled through the top opening of the elbow. It is important that the thread fittings on the wiring side of the thermal head be waterproofed with white lead, and that the right angle bend in the conduit be sufficiently liberal to avoid cracking the pipe. If the heater is installed in a galvanized iron tank, it is a good idea to see that the tank is thoroughly grounded. This precaution eliminates most of the danger from shock. However, with reasonable care in following the above directions little difficulty will be experienced in securing a very satisfactory stock tank water heater installation.

Stationary Spraying System Installed on West Virginia Branch Experimental Farm

THE State of West Virginia has purchased an experimental farm of about 154 acres, to serve as a branch of the agricultural experiment station, and form a field laboratory for research in horticulture, plant pathology, entomology, agricultural engineering, and agronomy. The farm is located in one of the most important apple producing sections in the East.

Investigational work on stationary spraying systems has been under way at the West Virginia Station for two years, and a new plant installed on the farm under the direction of the agricultural engineer embodies the latest developments in this type of system. The system forms a part of the research equipment for continued study of stationary spray plants. Incidentally, it is the first such plant in the state operated by electric power.

F. D. CORNELL.

The Engineer and Tillage Research[1]

By H. B. Walker[2]

THE agricultural engineer is concerned with the practical application of science and scientific methods to the industry of agriculture. In these matters he must not overlook the all important factor of practicality, for his efforts to be justified, must result in economic benefit to those who utilize directly or indirectly his services.

The Engineer's Approach. The engineer's approach to agricultural problems is essentially through the application of the basic physical sciences, otherwise he would not be an engineer. However, many of the achievements of the engineer in solving agricultural problems must be evaluated by plant and animal responses, the fundamental development of which is dependent upon the biological sciences. On the other hand, the engineer should not have difficulty in recognizing that his services have a place in this industry because most farm operations involve power, labor and materials, factors which are at once familiar to the industrial engineer. Yet, when the engineer extends his analytical methods into the problems of crop production, he finds himself confronted with many new and somewhat perplexing scientific relationships.

Engineering Efficiency. In all industrial operations involving power and labor, machines (materials) are a counterpart. It is the traditional method of the engineer to measure the effectiveness of a machine by its efficiency; that is, the relation of output to input. For many industrial operations the mechanical efficiency represents a satisfactory measure, and this holds true in general for many agricultural operations such as pumping water and elevating and grinding grains. Such tests have enabled the designer to produce more efficient machines requiring less energy input and less labor per unit of output. For example, the silage cutter has responded to mechanical efficiency studies which have stimulated better designed machines and improved operating practices. The engineer, once he has a measuring stick to test the effectiveness of his efforts, is usually able to make practical applications of science and scientific methods to industrial operations and processes, but in the absence of such devices progress is slow, tedious and often misdirected.

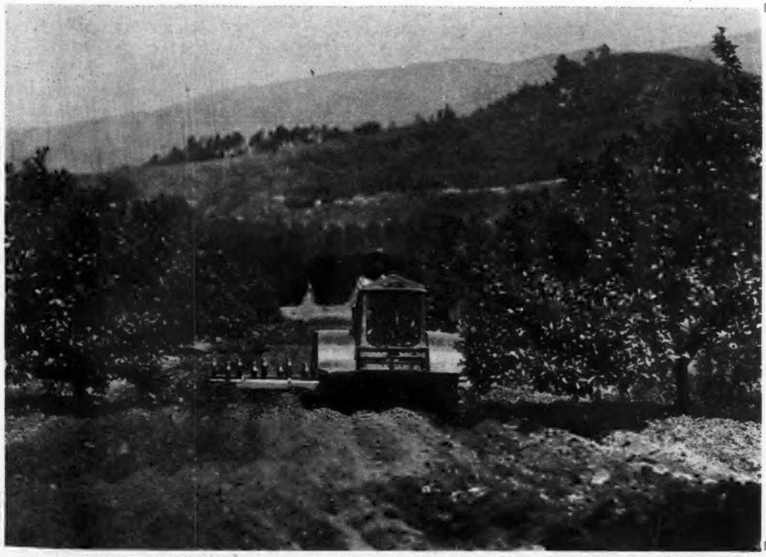
Tillage Consumes Power. The industrial engineer in agriculture who concerns himself with the power, labor and materials used in production is confronted with the intricate and involved scientific relationships of tillage practice. Tillage operations consume a relatively large proportion of the total agricultural power. Statistics indicate that field operations constitute about 48 per cent of farm draft work, and that tillage work such as plowing, listing, fitting ground and cultivating crops makes up approximately 58 per cent of the total horsepower-hours utilized in field operations. In 1928[3] this was estimated to be approximately 4,900,000,000 horsepower-hours for the farms of our nation and these cost our farmers approximately one billion dollars.

Effective Power Applications Essential. More economical practices are constantly being developed from better adapted and more efficient power units. This is particularly true at present in the substitution of mechanical for animal power. Further development of this transitory power condition in farming may be expected, with attendant decreases in farm production costs. The agricultural engineer, however, should not be content with limiting his analytical methods to primary power units. The application of this power to production is equally if not more important. The energy provided by a primary power unit is dissipated into field operations of which plowing, fitting and cultivation are great consumers. The efficiency with which these operations are executed is no less important from an engineering standpoint than an efficient primary power unit. Soil manipulations coming

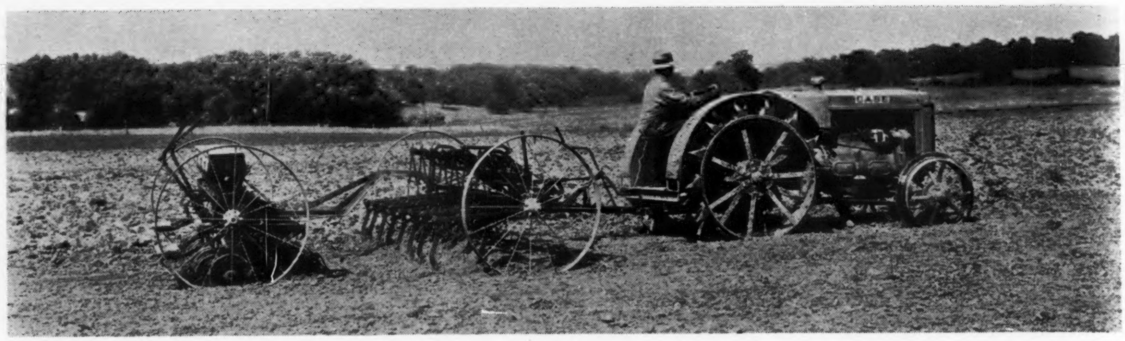
[1]Paper presented at the 24th annual meeting of the American Society of Agricultural Engineers at Moline, Illinois, June 1930, as a contribution of the Pacific Coast Section of the Society, H. B. Walker having been designated as chairman of a committee to prepare it.

[2]Agricultural engineer, California Agricultural Experiment Station. Mem. A.S.A.E.

[3]Harvey Fisk & Sons. "The Tractor Industry and its Part in Power Farming," Jan. 1929, p. 11.



Our conceptions of the functions of tillage practice have changed materially in the last quarter of a century and there is yet much that is not fully understood. To attempt to produce field crops on a practical basis without tillage is unthinkable, yet economic pressure requires that the energy used should be a minimum consistent with optimum monetary returns



In tillage operations the agricultural engineer through the application of his own technical training can supply data directly for farm management

under the general category of tillage, may include the inversion of a furrow slice, or it may be merely the slicing and turning on edge of a soil section, again the soil may be shattered or scarified or it may be stirred by shovels or compacted or crushed. To do these various operations involves the translation of power from the primary unit to the field operation. Between the primary units and the various field operations are machines which we classify as tillage implements. The design and effective application of these machines are engineering problems, yet because of the nature of the requirements placed on such, it is very difficult for the engineer to follow analytical methods of design such as are now common in the design of most mechanical equipment.

Tillage Necessary. Our conceptions of the functions of tillage practice have changed materially in the past quarter of a century, and there is yet much that is not fully understood. To attempt to produce field crops on a practical basis without tillage is unthinkable, yet economic pressure requires that the energy used should be a minimum consistent with optimum monetary returns. Naturally the engineer has been slow to analyze tillage machinery. He has depended upon the agriculturist to set up the requirements of good practice and with these as a specification he has utilized his own technical knowledge in the use and application of materials to develop our tillage equipment.

Functions of Tillage. The more important functions of tillage may be stated as follows:

1. To control weed competition.
2. To produce a favorable environment for seeds.
3. To incorporate crop debris, natural fertilizers and sometimes artificial fertilizers with the soil.
4. To prepare land for the application and distribution of water and for subsequent field operations.
5. To control pests and plant diseases.

These constitute the functions regarding which there is a rather general agreement among scientific workers. In addition the following may be mentioned as being of a more or less controversial nature:

1. To promote the more favorable action of soil bacteria.
2. To prevent soil deterioration on cropped areas by erosion from wind and water.
3. To improve the physical condition of the soil.

These various functions in total comprise the factors which contribute to that intangible term known as soil tilth. Naturally there is some overlapping between these various functions and a single tillage operation may satisfy one or more of these purposes. In addition, other minor requirements may be set up but those given cover the more important items. Not many years ago tillage was considered essential for the control of soil moisture, but this theory has been discarded for the more logical requirement of weed control.

Tillage Analysis. When one thinks of the many crops produced on the various soil types under varying conditions of temperature and moisture, it would seem almost impossible to analyze the functions of tillage by any rational method, such as is needed to enable the engineer to design power and machinery units on a measurable efficiency basis. This problem, involving as it does a blending of the physical and biological sciences for a solution, and being somewhat further complicated by a lack of clearness of understanding among those interested, may seem too complicated for the engineer to attack. On the other hand, an analysis must be made of these factors if the engineer ever hopes to escape empirical methods in the design of tillage machinery.

Methods of Approach. There are two general methods of approach in the development of new material in tillage practice by the research method. One involves an approach based upon fundamental physical laws, while the second calls for an analysis involving the application and measurement of both physical and biological phenomena. Of these two approaches, the former is probably the more attractive to engineers. It is simpler also because it involves fewer variables. The second method calls for a close correlation of effort between workers in both the physical and biological sciences. It is necessarily more complex but likewise more basic in character.

Energy Analysis of Tillage. The approach to the machinery problems of tillage through the former method must be based primarily upon energy input in field operations and then these operations should be correlated with yields in evaluating results. This involves three groups of variables, namely: (1) The energy input in the operation, (2) the character of the field operations including types of equipment, and (3) the economic relationships of (1) and (2) to production and net profit. This approach to the problems of tillage and tillage machinery has more merit than might be assumed at first. Particularly is this true at the present time when management in production is of such paramount importance. The industrial manager is constantly seeking ways to lessen costs. In this search he must maintain satisfactory quality, and he must produce in such quantity as will afford the greatest net return for the use of plant and equipment. The factors already mentioned, viz: energy input, types of machines and correlation of results with output constitute a real basis for constructive production managament in agriculture.

Energy Analysis an Engineering Problem. In tillage operations the agricultural engineer through the application of his own technical training can supply data directly for farm management. The efficient application of energy to any operation is primarily an engineering problem. The measurement of this applied energy is based primarily on the application of the physical sciences. The observations of energy consumed in various field operations with various types of field tillage apparatus may be correlated readily with production results and net in-

come. This is engineering economics. All of this appears at first thought to be a simple matter and to many of you these data may seem to be available already. It is true that the modern farm manager usually knows the man-hours and the tractor or horsepower-hours required to produce an acre of crop. He may also know the gallons of fuel or pounds of feed needed to do this work, but we do not have adequate metering apparatus to measure readily, over a wide range of conditions, the energy cost of field operations from the use of different implements which may be used in such operations as plowing, disking and cultivating. We have been successful, in a measure, in determining the total energy cost of crop production, but as yet we haven't broken this total cost up into its various component parts. Agricultural operators, generally, do not fully appreciate the energy cost of crop production as it relates to different machines and methods of use. The time element in tillage perhaps has made it difficult to place a proper value on a fixed unit of energy like the horsepower hour. However, we do know that it may take from 4.5 to 33.0 horsepower-hours[6] to plow an acre of land six inches deep, and this offers such a wide range of energy input as to encourage specific studies as to the causes for these variations. Many of these causes are apparent, but others, particularly those with reference to different practices resulting from the use of different machines on the same soil types, are not so well understood. These problems are of particular significance just now because of the recent public attention directed toward limited production. Limited production if it is to be justified at all, should be directed toward our marginal production areas. Otherwise it can have little economic justification.

Measurement and Metering Energy Requirements. We as engineers should be able to determine by simple methods the horsepower-hour consumption of various types of field machines, especially soil tillage apparatus used in crop production under varying conditions. The adoption of a practical energy unit is the simplest way of directing attention to this factor since it supplies the non-technical workers with a ready means of visualizing the economic value of a requirement or practice.

Practically speaking, the agricultural engineer has not yet developed a metering apparatus which can be inserted between the power unit and the field machine for a ready determination of the drawbar energy consumed, and which may be used on a large scale by farmers the same as electric, gas or water meters. As long as we must depend upon existing types of drawbar dynamometers to secure such data we will not secure sufficient volume of information covering a wide range of conditions to be of value in focusing attention to the specific controls in economic tillage practice. We need to develop a drawbar meter capable of doing a service similar to the watthour meter. It is not the function of this paper to tell how this can be done but rather to express the need. Its development, however, is essentially an engineering problem. Such a metering device involves the integration and recording of only two variables: pounds of pull and distance traveled.

[6]Kinsman, C. D. "An Appraisal of Power Used on Farms," Table V, p. 57, Bulletin 1348, U.S.D.A. Feb. 1926.

[7]Shaw, Chas. F., "The Soil Mulch," Jour. Am. Soc. Agron., Vol. 21, No. 12, p. 1197, Dec. 1929.

In the future tillage machinery is going to be challenged by scientists who will demand that it function in accordance with the new knowledge they uncover.

The variable character of these two factors under field conditions, however, complicates the construction of a practical metering equipment which is capable of withstanding the hard usage incident to agricultural operations.

Energy input data arouses the curiosity of the operator, and a measuring device which will provide such data would be the means of stimulating widespread interest in an involved problem. With such data the controls in tillage practice could be more readily segregated and balanced against economic returns, in a way which would enable farmers to better capitalize machines and thus definitely fix the economic margins for improved machine design.

The Biological Approach. The second method of attack on the problems of tillage is more involved from an engineering point of view and the resulting values less tangible. Many new tillage concepts have developed in the past two decades. Not many years ago deep and frequent tillage was considered good practice and soil mulches were thought to be desirable for moisture conservation. These concepts have since been greatly modified if not entirely discarded. Scientific investigations have shown the fallacy of some of our traditional methods. Shaw[7] says, "The soil mulch can reduce the loss of soil moisture only when the water table, perched or permanent, is within the capillary rise of the surface." In general it is now recognized that less tillage than formerly practiced is desirable, but the tillage which is needed, must be done to meet specific requirements, and timeliness of operations has become of great importance.

Machines a Factor in Tillage. These changes in practice have not been entirely independent of the improvement in field tillage equipment. With more flexible farm power, larger machines, increased wages and an appreciation of the factor of timeliness of operations, the incentive to seek new practices and methods has been greatly stimulated. In early days the tillage of the soil was more or less incidental to a traditional agricultural system. Little thought was aroused as to method of procedure or soundness of practice. Today it is just the reverse. Every farming practice is being questioned. The statement, "When people do not think they believe, and when they begin to think they begin to doubt," surely applies to tillage practice.

Tillage a Difficult Engineering Problem. Tillage is a difficult engineering problem. On the one hand we are concerned with energy input for the purposes of economic production and on the other we are concerned with plant responses, soil stimulation, moisture utilization and other problems relating to, or dependent upon, the biological sciences. Plowing, as an example, is a general tillage practice throughout the world, yet today there is more questioning regarding the way to plow or till the soil than ever before. Today we have a wide choice of methods. One may scarify or chisel the upper soil layers or invert the furrow slice, or the furrow may be turned on edge, or it may be sheared loose and beaten with tillers, or milled with a rotating cylinder, or simply stirred with duckfoots. Each of these methods may have merit and usually this is true if a practice is followed generally in a given locality.

Moisture Relationships. In all of these various methods it is now generally understood that to plow, or otherwise till the soil when it is too wet is detrimental to its structure, resulting in an unfavorable environment for plant life. The term "soil wetness" is a relative one which may be influenced by soil texture and subsequent climatic exposures. No doubt this moisture relationship is of greatest significance where the finer textured soils are encountered and in areas where little if any freezing occurs. The adobe soils in certain sections of the Pacific Coast area are a good example. The moisture relationship in tillage is directly related to that intang-

ible factor of soil tilth, which in turn is closely related to the ability of soils to absorb water. To plow or cultivate soils when wet produces plow pan which may require some type of mechanical stirring later to restore the soil to its proper physical condition. Soils cultivated when dry do not develop this condition. The optimum moisture content for safe plowing or cultivation has been given by some soil technologists as approximately two-thirds of the moisture equivalent for the soil. This is, however, a very general statement which must be used with caution since it can not be applied to all conditions with safety.

Practical Considerations. Cultivation for certain crops may permit more specific requirements for moisture relationships in tillage than others. Tree crops for example may not suffer much if tillage is delayed. We are not concerned with seedbed preparation in an orchard except for such cover crops as may be grown. The root system of a tree is very different from that of our annual crops such as potatoes, beets, wheat or corn. In orchards, crop cultivation may wait for proper soil dryness without serious effects upon yield. California[8] orchardists have been able to reduce tillage costs 50 per cent or more during the past five years without loss in yields; by practicing cultivation with the moisture content at or on the dry side of the optimum condition. With the other crops mentioned latitude in time of cultivation is not wide. There is a timeliness factor in season as well as moisture and often a farmer may feel justified in cultivating on the wet side of the optimum condition even at the risk of later finding it necessary to break up the plow pan by mechanical means. It should not be inferred, however, that it is a justifiable practice to plow or cultivate lands when too wet. It emphasizes, however, the necessity of adequate drainage and irrigation systems to meet a more rigid tillage requirement and the design of machine sizes which will provide a timeliness factor of saftey which has economic justification.

Soil Tilth. Tillage influences soil tilth. Naturally one asks next what is tilth. Dr. Bodman[9] says "Tilth implies a plant-soil relationship, and good tilth is generally considered to mean such physical condition of the soil most favorable to plant growth. Consideration of tilth involves a consideration of resistance to root penetration, state of flocculation and resistance to deflocculation and existence and permanence of crumb structure, moisture retentivity and capacity." Some of these things are independent of tillage manipulations yet tillage undoubtedly influences tilth. The incorporation of crop residues, the mixing of fertilizers, and moisture relationships when tillage occurs are of direct importance. Quoting Dr. Bodman again, "Resistance to root penetration and moisture capacity are both more or less dependent upon soil volume weight. The volume weight is in part dependent upon the existence of a crumb structure. Both crumb structure and volume weight are directly or indirectly dependent in part upon tillage methods and implements. There is need for knowledge of just what constitutes the most desirable pore space and volume weight for the growth of different plants. The effect of different implements and tillage methods upon volume weight provides a starting point for the probable ease of root penetration which may be checked by actual effect on plant growth."

Machine Relationships. It is apparent that while a tillage implement can not influence soil tilth unless operated in the soil to stir the surface in meeting one or more of the requirements of tillage practice it may, nevertheless, be an important factor in the creation of a favorable environment for seeds and plants. The engineer who designs a tillage implement would welcome methods of tilth measurement which would enable him to objectively determine the functions of the implements he creates. As engineers we should like to know how closely we can approach a specified condition of tilth with a given amount of soil manipulation. We should like to know the relationships of moisture, crumb structure, volume weight, etc., to specific tillage practices. We have already pointed out the desirability of measuring the energy flowing between the primary power unit and the implement, but the purpose of the tillage machine is to translate power into tilth. It is difficult to evaluate the work of a tillage implement unless there is devised some method of measuring relative effectiveness.

Weed Control. In considering this problem of soil tilth and machinery one should not overlook the problem of weed competition in crop production. Weeds not only dissipate moisture, but they consume plant food and otherwise set up environments which may be detrimental to profitable crop production. Regardless of the progress that has been made in killing weeds by chemicals, tillage still represents the universal method of control. Weed elimination is practically impossible. When a seedbed is prepared for a crop, one is likewise created for the weed seed which will later compete with the planted seed unless eliminated through selective cultivation. To properly eliminate weed competition in cultivated crops requires the greatest skill upon the part of the farmer, if he would not violate some of the principles set up for the maintenance of soil tilth. If he permits his land to become sufficiently dry for tillage, the weeds may create in advance an unfavorable environment for his crop; if he tills when it is too wet, he may create plow pan, which in turn sets up a resistance to water penetration and which may later be the cause of surface erosion.

Timeliness Important. Thus it is that tillage becomes complex for the farm operator. He must rely upon his implements to serve him during the critical periods. In many cases it isn't duty of machinery that is important but rate of work. When the environment is favorable for tillage the rate must be sufficient to accomplish the task in the allotted time. In other words, timeliness of operations is constantly gaining in importance, and this is of great significance to the engineer because this factor will determine to a large extent the number and size of machines required to produce a given crop under local climatic conditions. This factor of timeliness is destined to become increasingly important in agricultural management. With the decline of natural soil fertility greater efforts must be made to improve the physical condition of soils as well as to build up available plant food through the application of fertilizers. For example, the incorporation of cover crops in the soil is likely to become a more general practice. The maximum returns from this practice depend upon the incorporation of the succulent crop at the proper stage to utilize its valuable constituents. Waksman[10] found in his studies of the chemical and microbiological principles underlying the decomposition of green manures in the soil, that "the water soluble constituents are highest when the plant is young making up as much as 40 per cent of the dry matter of the total plant material. This percentage decreases with age so that mature plants may contain only about 5 per cent . . . . . Lignins . . . . . are low in young plants and increase in proportion with the age of the plant, both in total quantity and in relation to the other plant constituents. The lignins which make up 5 to 30 per cent of the dry plant materials are most resistant to decomposition in the soil. The nitrogen (or protein) content of plants is high at an early stage of growth and decreases with an increase in the maturity of the plants, frequently from 18 per cent protein in young plants to about 1.2 to 1.5 per cent in the mature straw." Such scientific studies no doubt will have a decided influence on the timeliness of cover crop practices,

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[8]Extension Service Reports, University of California.

[9]Bodman, G. B. Assistant Soil Technologist in the Experiment Station, Uni. of Calif.

[10]Waksman, Selman A., "Chemical and Microbiological Principles Underlying the Decomposition of Green Manures in the Soil." p. 1-17, Vol. 21, No. 1, Jour. Am. Soc. of Agron. Jan. 1929.

which of course must be reflected in field machines, and we may expect the development of similar scientific data bearing on other tillage practices.

New Requirements in Tillage Equipment Design. Agriculture is becoming more and more dependent upon machines and the requirements for field machines are becoming more exacting. In the future tillage machinery not only from the standpoint of use but also in design, is going to be challenged by scientists many of whom may not completely understand the problems of balanced farm production and farm machinery duty, although they will represent the latest scientific thought in their particular fields. This statement relates to the bacteriologist, microbiologist, plant pathologist, botanist and others, whom we as engineers may feel inclined to classify as the super-scientists in solving agricultural problems. The engineer to be able to utilize this new knowledge, must work in harmony with these scientists from the biological fields. Our direct and objective methods may be difficult to adjust to the less tangible results coming from the biologists. We have asked for ways and means of measuring tilth but, so far, with few tangible results. We have suggested such methods as the use of the penetrometer, measurement of the apparent specific gravity, crumbling modulus and others. It is doubtful if any one of these more or less arbitrary methods will provide a satisfactory index for tillage implement performance, but to know something of these relationships might prove helpful. We should conduct many experiments in this field of tillage. We should encourage the agronomist, soil technologist and botanist to do likewise. If tillage affects the volume weight of a soil and this in turn influences root penetration and moisture capacity, then we should encourage the determination of the kind of tillage most appropriate, such as shallow or deep tillage, inversion of the furrow slice, or turning it on edge, the optimum moisture content for different types of soil, the best method for weed control and other fundamental relationships which are outside of the direct engineering field.

Engineering Procedure. It is apparent the agricultural engineer has a clear and open field for the development and measurement of the energy used in tillage practice. He should aggressively attack these problems. In the translation of power into soil tilth his activities are less clearly defined. Better definitions as to moisture limitations for tilth, specific requirements for weed control, properly defined conditions for the incorporation of crop residues, and other requirements which can be set up best by our biological scientists will make the work of the engineer more effective.

Caution Needed. The more one thinks of these intricate relationships the more impressed he becomes of the need of caution. Not many years ago the engineer was the aggressor in the design of new types of agricultural machinery. Today, while still aggressive, he is more on the defensive because he recognizes the radical nature of some of the new scientific principles developed with reference to tillage practice. He should, however, be quick to adjust equipment to new methods of proven worth.

Summary. The most effective endeavor of the agricultural engineer in the development of new data for better understanding and more efficient practices in tillage problems is to:

1. Develop ways and means of metering the various energy demands of tillage machinery operating under varying conditions and then correlating these data with production returns.

2. Study carefully the relation of power and machinery units to timeliness of tillage operations.

3. Work with the biological scientists in determining the requirements of tillage practices to meet the conditions for profitable crop production.

4. Seek analytical methods of measuring soil tilth.

The Electric Hotbed[1]

By R. H. Denman[2]

THE use of the electric hotbed is the result of economic changes which in turn are the result of two lines of engineering progress. One is the development of the automobile, truck and tractors resulting in a decrease in the horse population with a deficiency in the right kind of manure for hotbeds; the other is the improvement in the generation and distribution of electricity which makes power available at a low price.

Those farmers and growers who forced seedlings formerly depended largely on the horse stables in the cities to supply them with manure for use in hotbeds. They had learned by years of experience how to make use of the heat produced by the decomposition of horse manure to hasten the germination of seeds and the growth of seedlings. This manure has become difficult to secure and high in price, and, furthermore, the extra labor required by manure hotbeds is an important item now.

Electricity is more than a substitute—it is an improvement over manure in many ways. It is adaptable to either the large or the small grower as it may be used to heat a hotbed with one 3x6-foot sash or a multiple bed with two, four, six or more sash.

[1]A contribution to the symposium on rural electrification presented at a meeting of the North Atlantic Section of the American Society of Agricultural Engineers, at Amherst Mass., October, 1929.

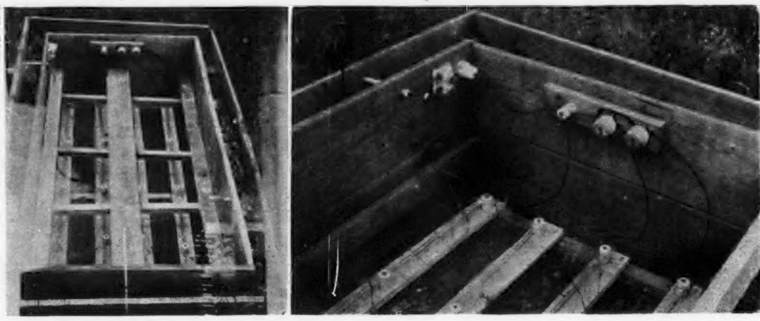
[2]Rural service specialist, New York Power and Light Corp Aff. Mem. A.S.A.E.

[3]Glenn Cushing, rural electric service department, Puget Sound Power and Light Co.

The electric hotbed may be started up at any desired time on short notice, whereas in the case of the manure hotbed work in preparing the manure must be started about two weeks in advance of the time it is desired to sow the seed. It requires a certain amount of forking over and mixing and waiting for a preliminary heating to subside. This preliminary heating is apt to cause so much heat as to kill the seed. After germination, the seedlings, if spindling and tender due to excessive heat and dark weather, are subject to "damping off" and other fungus troubles. Where the heat is controllable as in the electric hotbed, it may be reduced to slow the growth in dark weather, thus making stronger plants. In the electric hotbed, moisture conditions are under better control and the air surrounding the seedlings may be kept drier thus reducing disease. With the manure hotbed, growers often lose thousands of plants in dark or damp weather from fungus diseases.

Before setting in open ground seedlings must be "hardened" by placing in a cold frame which is simply a frame with a sash over it. The only source of heat is the sun. The sash is left partly or entirely off when the weather is suitable, and about the time plants are to be set out, it is left off all the time. Where manure hotbeds are used the cold frames mean a separate set of equipment. The electric hotbed can be instantly changed to a cold frame by turning off the current.

Heating units for electric hotbeds may be successfully constructed by the stretching of coils of resistance wire on a frame to be placed in the bottom of the bed. The



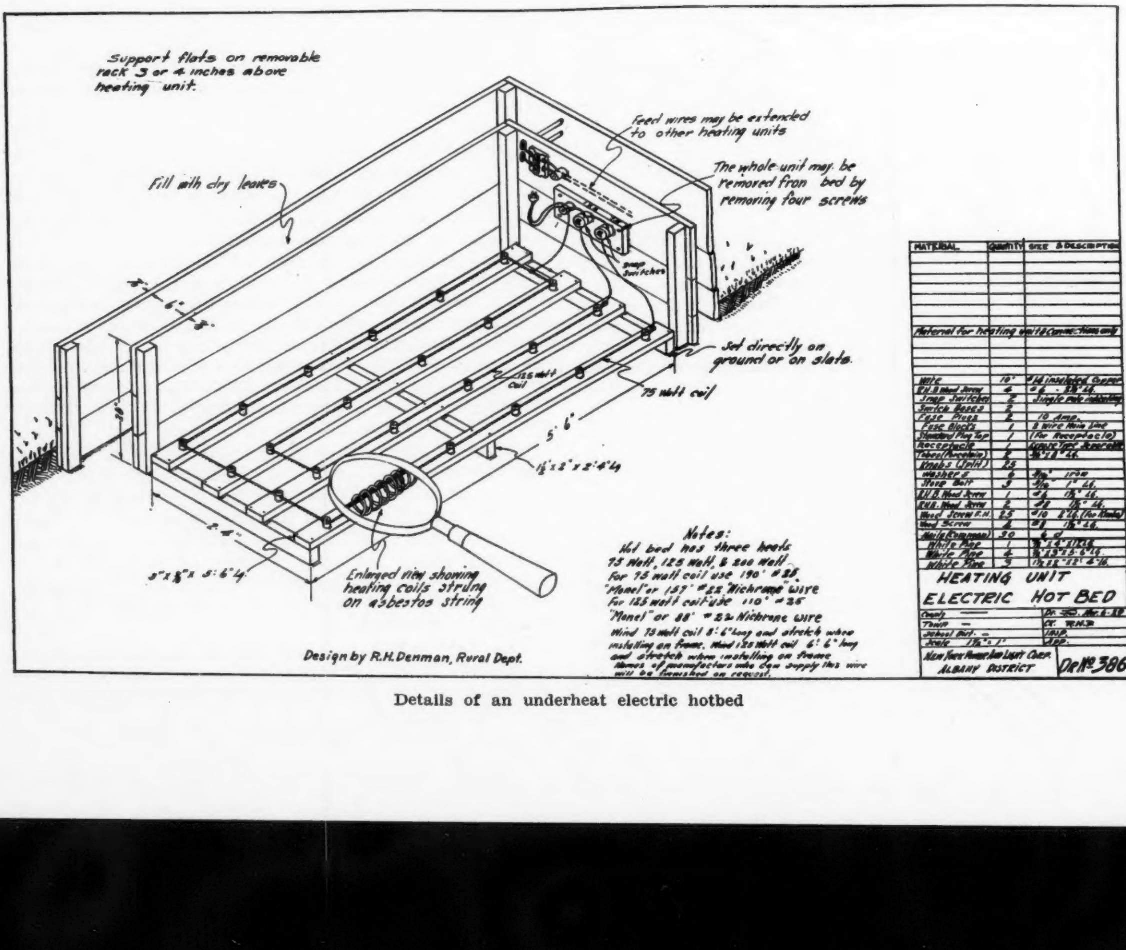
Two views of an underheat electric hotbed ready for putting in the soil flats

coils should be of the proper resistance to operate at "black heat" (572 degrees Fahrenheit) and arranged to distribute the heat pretty well over the whole area of the hotbed. A 75-watt coil and a 125-watt coil with a switch for each may be used. This makes three heats available, 75-watt, 125-watt and 200-watt. By watching the thermometer ,the operator will soon learn what coils to have on to maintain the desired temperature under various weather conditions. Hotbeds have been successfully operated with 50-watt and 100-watt coils in this latitude, but the wattages first given will better take care of severe weather conditions which may occur early in the season.

The soil in which to sow the seed may be spread on a false floor three or four inches above the heating unit or preferably in flats on a removable rack. In the latter case the heating unit is less likely to be injured upon removal of the soil.

The capacity of the heating units used varies from 112 watts to 200 watts per 3x6-foot sash (6.25 to 11 watts per square foot of sash). The heat is controlled either manually or by a thermostat. A disadvantage of therostat control is that it does not prevent overheating under warm and sunny weather conditions. The beds may also be kept too warm at night, forcing growth which is inconsistent with the amount of light received. Of course the current may be shut off at night and ventilation resorted to in the daytime. Ventilation is always desirable in any case. An ether wafer-operated toggle for opening ventilators on hotbeds has been designed by Cushing[3] and was first used at the Western Washington Experiment Station.

I have been studying the problem of supplying artificial light to supplement sunlight and avoid the necessity of reducing the temperature surrounding the plants. Since the energy of light sources is mostly heat, it appears to be practical to supply the heat from light sources placed above the soil and plants. An experiment on this basis resulted in the production of stockier and darker colored plants. The plants developed more rapidly. Radishes grew their second pair of leaves within seven days from sowing which was several days in advance of the underheated plants. It may be that warming the plants and the soil directly by radiant heat, the surrounding air being at a lower temperature, may be an advantage. If so the method of supplying heat from a light source will be well adapted to the heating and ventilation of hotbeds. Further experimentation is required along these lines.



Details of an underheat electric hotbed

Agricultural Engineering Digest

A review of current literature on agricultural engineering by R. W. Trullinger, specialist in agricultural engineering, Office of Experiment Stations, U. S. Department of Agriculture. Requests for copies of publications abstracted should be addressed direct to the publisher.

[Agricultural Engineering Investigations at the Missouri Station], J. C. Wooley et al. (Missouri Station (Columbia) Bulletin 272 (1929), pp. 29-31).—Data from 40 farms on the cost of using electricity for feed grinding, machine milking, cream separating, machine washing and water pumping are briefly summarized by R. R. Parks and M. M. Jones.

Tests by Jones and A. H. Glaves of the effect of manuring silt loam soil on plow draft showed no difference in draft from various amounts of manuring. The average draft of wide-bottom plows was found to be considerably less than that of narrow-bottom plows on silt loam soils.

A continuation of the tests, by Jones, of fence post treat-, showed that charring the butts of sycamore, red oak and Kentucky coffee bean posts increased the serviceable life, but had no beneficial effects on the other varieties. Painting with hot carbolineum doubled the life of many of the soft woods This treatment was more effective than hot creosote applied in the same manner. Painting with hot creosote was not effective. In the 14 varieties that have failed to date, the 2-hour double treatment with creosote has increased the serviceable life 2.9 times. The 5-hour double tank treatment of creosote has increased the serviceable life 3 times. For the varieties that have failed to date, the 2-hour treatment was practically as good as the 5-hour treatment.

Smokeless Combustion in Domestic Plants, V. J. Azbe (Mechanical Engineering (New York), 51 (1929), No. 10, Sect. 1, pp. 761-764, figs. 4).—A brief discussion is given of the principles involved in smoke elimination and different methods of furnace firing, and practical suggestions are given on how to avoid smoke and dirt and secure efficient heating in the small domestic furnace.

Development of a Power Dusting Device for Applying Paris Green as an Anopheline Larvicide, J. A. LePrince and H. A. Johnson (Public Health Reports [U. S.], 44 (1929), No. 17, pp. 1001-1017, pls. 6, figs. 10).—A dusting machine for destroying mosquito larvae by use of Paris Green is described. This machine consists of a power generator, an electric blower and a small dust hopper. The whole unit is set in a small boat, and the blower is operated by one one man.

It has been found that the material costs for dusting are as low as 15 cents per acre. Hydrated lime is the most satisfactory diluent tested for use with Paris green in the power blower. Fifteen per cent Paris green mixture gives most uniform results. Moderate breeze velocities, not over 7 or 8 miles per hour, are most satisfactory, and in breezes less than 2 miles per hour the nozzle should be well elevated. In moderate breezes less than 2 miles per hour the nozzle should be well elevated. In moderate breezes a 15 per cent Paris green mixture gives a lethal path at least 525 feet wide.

Resistance of Metals Suitable for Dies to the Abrasive Action of Plastic Clay (Journal Franklin Institute (Philadelphia), 208 (1929), No. 4, pp. 555, 556).—The results of studies conducted at the U. S. Bureau of Standards on the wearing action of plastic clay on cast iron and carbon-chrome steel are reported.

During each test a definite volume of clay is extruded through the die specimen in a definite time and the abrasive loss of the die is expressed in terms of volume. This is determined by dividing its loss in weight by the specific gravity of the metal.

A very small decrease in water content of the clay produces a marked increase in the pressure necessary to extrude the clay at a definite rate, and the abrasive loss of the die increases with the extrusion pressure. The data obtained from 54 tests indicate that the relation between extrusion pressure and abrasion loss of the metal is a "straight line" function, according to the equation $PS/W=K$, in which P is the extrusion pressure, W the loss of the metal in weight, S the specific gravity of the metal, and K is a constant characteristic of the wearing quality of the metal. The value of K for the cast-iron die as compared to that for the carbon-chrome steel die is as 1 to 10.116.

Carbon Deposits from Lubricating Oils, C. J. Livingstone and W. A. Gruse (Industrial and Engineering Chemistry (Washington, D. C.), 21 (1929), No. 10, pp. 904-908, figs. 4).—Experiments conducted at the Mellon Institute of Industrial Research with heavy duty sleeve-valve and poppet-valve engines are reported. It was found that in sleeve-valve engines paraffinic oils differing markedly in carbon residue value differed only slightly in amount of carbon deposited, while a naphthenic oil was greatly superior to both. For poppet-valve engines the laboratory experiments indicate that the carbon residue value remains a fairly reliable index of the carbon deposit to be expected.

Annual Report of the Department of Sewage Disposal for the Year Ending June 30, 1928, W. Rudolfs (New Jersey Station (New Brunswick) Bulletin 486 (1929), pp. 80, figs. 28).—Various studies of the biology of sewage disposal conducted during the year are described and the results summarized.

With reference to the color of sewage sludges it was found by Rudolfs and C. N. Henderson that the common belief that a color of sewage solids indicates good digestion is erroneous. This was borne out by checking a number of sludges from disposal plants from different parts of the country. The ash content of the different sludges is a fairly good indication, however, provided the initial ash content of the material is known.

In studies by P. J. A. Zeller of the effect of freezing on sludge digestion it was found that gas production stopped completely at a low temperature of -2 degrees (Centigrade), increased gradually above 12 degrees and resumed its original rate as soon as the mixture had reached 20 degrees. The total gas production per gram volatile matter was not altered by freezing, regardless of whether the freezing was practiced at the beginning or during the course of digestion. The percentages of volatile matter reduction and ash increase were not affected by prefreezing or freezing at intervals. Prefrozen ripe sludge was as effective for seeding purposes as unfrozen material.

Rudolfs and I. O. Lacy found that dye manufacturing waste containing chlorides, sulfates, iron, and dye retared the digestion of a mixture of this waste with domestic sewage sludge. A sewage disposal plant receiving this particular type of trade waste would very likely require about 25 per cent larger sludge digestion capacity than a disposal plant not receiving this waste.

In studies by Rudolfs and Zeller of the effect of reaction control on gas production from sludge, samples of unseeded fresh solids were digested at temperatures of 24 and 30 degrees, with and without the application of lime. The gas collection data showed that with the reaction adjusted to pH 7.6 and at a temperature of 24 degrees the peak of gas production was reached in half the time required by the unlimed sample. The quantity of gas produced per gram of volatile matter was increased 16 per cent by liming and 20 per cent by the higher temperature. The average rate of gas production up to the peak was increased 185 per cent by liming and 68 per cent by higher temperature. The average composition of the gas was practically the same in all cases over a period of 200 days. The fuel value of the gas, in the case of the limed sample, was sufficient to raise the digesting material from 16 to 24 degrees in 12 days.

Studies by H. Heukelekian on the effect of sterilizing fresh solids on the digestion of seeded mixtures showed that the addition of sterile fresh solids to ripe sludge does not retard digestion, but on the contrary seems to have a stimulating effect which may be due to the increased availability of the substances in fresh solids on heating.

In studies by Rudolfs of the decomposition of relatively pure nitrogenous and carbonaceous materials and oils in sewage, great differences were found in the production of acidity, alkalinity, ammonia, nitrates, and the amounts of gases produced. All substances produced odors.

Heukelekian found that mineral oil is far more resistant to decomposition (if decomposed at all) than cod-liver oil and olive oil. The latter caused a greater stimulation of the bacteria, gave a greater alkalinity, biochemical oxygen demand and volatile matter reduction.

Rudolfs found that the changes in the composition of the gas produced during the course of digestion of fresh solids were considerable. The carbon dioxide content varied from 37.7 per cent during the first week to 25.3 per cent at the end. The methane content varied likewise from 47.8 to 69.8 per cent. From this and other experiments it is deduced that for practical purposes from 80 to 85 per cent of the possible total gas produced is the practical limit.

An experiment by J. T. Pedlow to determine the source, the identity, and the changes taking place in the character of the material suspended in the liquid above digesting sewage sludge showed that during the first stage of decomposition the major portion of the suspended matter is finely subdivided carbonaceous material. The fine state of subdivision is accomplished in the sludge layer during acid digestion, and the material is transferred to the liquid layer by gas bubbles. It remains suspended because its density is practically the same as that of the liquid. The mass of this carbonaceous material is returned to the sludge layer by flocculation and the rest of the suspended matter is decomposed in the liquid in a manner similar to the decomposition in the sludge layer.

Data from other studies are also briefly discussed.

Carbon Deposits with Heavy-Duty Engines, C. J. Livingstone, E. C. Martin, and S. P. Marley (S.A.E. [Society of Automotive Engineers] Journal (New York) 25 (1929), No. 5, pp. 489-494, figs 3.)—The substance of this report is noted in the above.

Estimation of Brushing and Flowing Properties of Paints from Plasticity Data, R. V. Williamson, G. D. Patterson, and J. K. Hunt (Industrial and Engineering Chemistry (Washington, D. C.), 21 (1929), No. 11, pp. 1111-1115, figs. 4).—The failure of yield value and mobility constants in the equation of flow for and ideal plastic to serve as a measure of the brushing and flowing properties of paints is considered to be due to two causes. First, the resistance to shear of a plastic substance varies with the rate of shear; consequently, the flowing properties of a plastic under any given practical conditions depend upon its resistance to shear at the particular rate of shear characteristic of those conditions. The individual values of the yield value and mobility constants do not show the variation in resistance to shear with rate of shear. Second, paints of brushing consistency do not flow in accordance with the law of ideal plastic flow.

Estimation of the relative brushing and flowing properties of paints from plasticity data is shown to be possible if the apparent fluidities or viscosities are compared at rates of shear characteristic of the practical conditions.

The application of a new equation for calculating apparent fluidities or viscosities at any rate of shear and the use of the constants of this equation as a measure of false body are given.

A method is presented for estimating the rate of shear characteristic of average brushing conditions or of other practical tests in which flow of pseudo-plastic dispersions occur.

Sewage Disposal for Rural Homes, E. G. Hastings, E. R. Jones and F. R. King (Wisconsin Agricultural College (Madison) Extension Circular 232 (1929), pp. 24, figs. 12).—Practical information is given on the planning and construction of adequate sewage disposal systems for farm homes in Wisconsin. The so-called Wisconsin septic tank is made with collapsible wooden forms for the concrete.

The Gluing of Wood, T. R. Truax (U. S. Department of Agriculture Bulletin 1500 (1929), pp. 78, pls. 13, figs. 18).—The purpose of this publication is to bring together essential information about glues and gluing, to set forth important principles of control in the gluing operation, and to outline methods found satisfactory. It has as a background a large amount of experimental work. Glue formulas are given in an appendix, together with engineering data on the calculation of pressure on glued joints. A list of fifty-four references to literature bearing on the subject is included.

Making Cellars Dry, G. M. Warren (U. S. Department of Agriculture Farmers' Bulletin 1572 (1929), pp. II + 29, figs. 19). —This bulletin supersedes an article entitled "Securing a Dry Cellar" and gives practical information on the causes of dampness and wetness in cellars, on methods on the exclusion of rain and drainage water, and on damp-proofing of cellar walls. Information is also given on the improvement of old cellars.

The Termite-Proof Construction of Buildings in Ceylon, F. P. Jepson (Ceylon Department of Agriculture (Peradeniya) Bulletin 85 (1929), pp. IV + 36, pls. 26).—A description is given of termite injury to wooden structures in Ceylon and some practical information presented on protection.

Farm Milk Houses, F. E. Fogle and P. S. Lucas (Michigan Station (East Lansing) Circular 123 (1929), pp. 7, figs. 4).— General information and working drawings for the construction of farm milk houses and equipment are presented.

Corrosion of Metals as Influenced by Surface Films, F. N. Speller (Mechanical Engineering [New York], 51 (1929), No. 6, Sect. 1, pp. 431-434).—A brief review is presented of the more important facts relating to the influence of metal surface films on corrosion, special attention being given to films and surface protective layers formed mainly by external reagents.

The influence of well-known alloying metals on the film-forming capacity of iron is also discussed, and the conclusion is reached that rust-resisting alloys, such as high-chrome iron and "stainless steel," probably owe their resistant properties to the stable films formed under certain conditions, and therefore that the life of these metals is more directly dependent on the stability of the film formed than on the initial tendency of the metal to corrode. Some metals evidently have much more of this self protecting property than others.

Simple Laboratory Experiments on Capillary Movement and Entrapped Air in Clays, D. P. Krynine (U. S. Department of Agriculture, Public Roads, 10 (1929), No. 6, pp. 114, 115, figs. 4).—Results of studies conducted at the Moscow Superior Technical School and Institute of Transportation Engineering are reported briefly. These indicate that in dry clay capillary movement may take place upward, downward, or laterally, and that the usual terms "capillary rise" or "capillary upward movement" convey an inexact idea and should be used to express a restricted meaning only. It is pointed out that capillary movement is due to molecular attraction of water by clay particles. During capillary movement water replaces air in soil pores and drives it forward.

Studies on the Action of Sulphates on Portland Cement.—I. The use of the expansion method in the study of the action of sulphates on portland cement mortar and concrete. T. Thorvaldson, D. Wolochow and V. A. Vigfusson (Canadian Journal of Research (Ottawa), 1 (1929), No. 3, pp. 273-284, pl. 1).—This contribution from the University of Saskatchewan and the National Research Council of Canada describes the methods employed in the use of expansion measurements as a means of studying the action of sulfates on portland cement and on portland cement mortars. Experimental data are given dealing with the reproducibility of the expansion measurements and the relation between expansion and loss of tensile strength of mortars. Results obtained with standard sand mortars and graded sand mortars of varying richness of mix prepared from cements which differ in their resistance to sulfate action are presented.

Studies on the Action of Sulphates on Portland Cement.—III. The effect of the addition of silica gel to portland cement mortars on their resistance to sulphate action, T. Thorvaldson, V. A. Vigfusson and D. Wolochow (Canadian Journal of Research (Ottawa), 1 (1929), No. 5, pp. 385-399).—Studies conducted at the University of Saskatchewan in cooperation with the National Research Council of Canada are reported in which the effect of substituting silica gel for a portion of the portland cement in standard and graded-sand mortars on the expansion and loss in strength of the mortars in sulfate solutions was determined. Portland cement silica gel sand mortars were cured in steam at 100 degrees (Centigrade) and the effect on their sulfate resistance measured. The behavior of lime-silica gel sand mortar in solutions of sodium and magnesium sulfate was also studied. It was found that the addition of silica gel to the mortar, very effective in preventing expansion and maintaining the tensile strength of the mortar in solutions of sodium and calcium sulfate, was not so effective in solutions of magnesium sulfate. Steam-cured mortars containing silica gel to the extent of 20 per cent of the cement present showed a slightly greater resistance to the action of solutions of sodium and calcium sulfates, but less resistance in solutions of magnesium sulfate, than similar steam-cured mortars containing no silica gel. Lime-silica gel sand mortars behaved very similarly in sulfate solutions as portland cement mortars containing silica gel. The possible causes of the effects produced by the addition of silica gel to portland cement mortars are considered, and several explanations discussed.

An Economic Study of Farm Buildings in New York, I. F. Hall (New York Cornell Station Ithaca Bulletin 478 (1929), pp. 87, figs. 78).—The results are reported of an investigation the purpose of which was to secure information regarding convenient arrangements for farm buildings. Detailed measurements were made of all buildings except the houses on 122 farms in several counties of New York. The results are given in considerable detail, but no very specific conclusions appear to have been drawn.

Studies on the Action of Sulphates on Portland Cement.—II Steam-curing of portland cement mortar and concrete as a remedy for sulphate (alkali) action, T. Thorvaldson, V. A. Vigfusson and D. Wolochow (Canadian Journal of Research (Ottawa), 1 (1929), No. 4, pp. 359-384, figs. 4).—Studies conducted at the University of Saskatchewan in cooperation with the National Research Council of Canada are reported of the effect of steam curing at various temperatures between 50 and 200 degrees (Centigrade) on the resistance of portland cement mortars to the action of solutions of the sulfates of sodium, magnesium and calcium. The methods used consisted in comparing the expansion of steam-cured and untreated mortar specimens during exposure to the solutions, and in determining the changes in the tensile strength of the more resistant mortars after long periods of exposure.

A laboratory study of steam curing as a remedy for the action of sulfates (alkali) on portland cement mortars was made by determining the effect on the stability of the mortar as indicated by changes in volume and in tensile strength on exposure to sulfate solutions at 21 degrees. The effect of steam curing on the tensile and compressive strength of mortars and concrete was also studied.

Curing in water vapor at temperatures below 100 degrees is of doubtful value on account of the loss in strength occurring during treatment. At a temperature of 50 degrees it decreases their resistance to the action of sulfates. Steam curing at 100 degrees for 24 hours or more materially increases the resistance of the mortar to the action of sulfates. The expansion of the specimens in solutions of sodium and calcium sulfate may thus be reduced to very small proportions, and the loss of strength greatly delayed. In solutions of magnesium sulfate the expansion is retarded, and the specimens gain strength as the volume increases up to a critical point at which they begin to develop cracks and lose their strength. The deterioration of the mortar is thus due mainly to gradual loss in strength in solutions of sodium sulfate or calcium sulfate, and to gradual increase in volume in solutions of mag-

nesium sulfate. The steam treatment at 100 degrees, however, produces mortars of low tensile strength. Therefore, while the treatment may increase almost indefinitely the life of a specimen exposed to solutions of sodium sulfate and calcium sulfate under laboratory conditions and increase the life of specimens exposed to solutions of magnesium sulfate to from 10 to 100 times that of an untreated mortar, steam-cured specimens are likely to fail when exposed to high concentrations of sulfates under severe climatic conditions.

The disadvantage of low tensile and compressive strength in steam-cured mortar or concrete may be entirely avoided and material of much higher resistance to sulfate solutions obtained by curing in steam under pressure at 125 to 175 degrees for 24 hours or more. The increase in volume and loss of strength of the mortar, in solutions of sodium and calcium sulfate, may thus be almost eliminated, and the expansion in solutions of magnesium sulfate reduced considerably.

The results obtained in the laboratory indicate that precast concrete such as tile of medium richness of mix made with clean siliceous aggregate can be rendered practically resistant to moderate concentrations of alkali. Where the concrete is placed outside of the reach of frost action and high strength is not necessary, steam curing at 100 degrees for 24 hours or more may be sufficient. For concrete exposed to high concentrations of alkali, especially of magnesium sulfate, and to large variations of temperature, the steam curing should be carried on in saturated steam at 150 to 175 degrees for a period of at least 24 hours.

Cost of Handling Citrus Fruit from the Tree to the Car in Florida, H. G. Hamilton (Florida Station Bulletin 202 (1929), pp. 317-428, figs. 37).—This bulletin reports the results of an investigation undertaken to analyze the facilities for handling citrus fruit in Florida and to determine the cost and the factors influencing cost. The data were obtained from the books of 99 packing houses for the season 1924-25, and from 83 of the same houses and 12 others in 1925-26. The itemized costs, total and average, per packing house and per box are given and discussed for floor labor; management; office; building; light, water, power, and house equipment; and field equipment for each year. A table is given showing the cost of handling citrus fruit in the four sections of the State. The factors influencing cost—investment, volume handled per packing house, volume per grower, capacity of packing house, the time the packing house was in use, number of boxes handled per car capacity of packing house, percentage of grapefruit to total fruit, precooling, one-story vs. two-story packing houses, floor area of packing houses, arrangement of building and equipment, rented vs. owned packing houses, distance fruit was hauled and year the packing house began operation—are analyzed.

The total handling costs per box for all fruits were 94.6 cents and $1.037, respectively, in the two years, of which the items were floor labor 11.3 and 13.5 cents, packing labor 6.6 and 7, management 4.1 and 4.9, office 1.9 and 2.6, packing-house building 2.9 and 3.5, land 0.5 and 0.5, light, water, power, and house equipment 5.6 and 6.7, field equipment 2 and 1.9, material 35.8 and 35,2, precooling 1.4 and 2.1, other direct cost 2.2 and 2.3, picking cost 10.2 and 12.9, and hauling 10 and 10.5 cents.

Correlation analysis of the factors influencing cost showed on the average that each 10 cents increase in investment per box increased the cost per box 3.8 and 2.2 cents, respectively, in the two years; that for firms without precooling systems each 10,000 boxes increase in volume handled per packing house decreased the cost per box 1.1 and 1.8 cents; that each 1,000 boxes increase in average volume per grower decreased the cost per box 2.8 and 0.6 cents; that each 10 per cent increase in the percentage of time the packing house without precooling system was in operation at full capacity decreased the cost per box 2.9 and 3.7 cents; and that each increase in volume per car capacity of 1,000 boxes decreased the cost per box 0.6 and 1.3 cents.

The following conclusions are indicated: Packing houses without precooling plants should not have a total investment exceeding 50 cents per box with a normal crop. A volume of at least 75,000 boxes is generally necessary for efficient operation. At least 15,000 boxes per season should be handled per car capacity. If the fruit of individual growers is kept separate until packed, at least 400 boxes per grower is necessary for reasonable cost. The best arrangement for a packing house is a one-story building with conveniently arranged equipment and from 0.1 to 0.4 square feet of floor area per box handled.

Appendixes include a copy of the schedule and a discussion of the correlation method used in the study.

The Effect of Ultra-Violet Radiation on Blood Formation in Young Pigs, F. P. Mathews, L. P. Doyle, and R. A. Whiting (American Journal of Physiology, 88 (1929), No. 4, pp. (616-619). —Continuing their studies at the Indiana Experiment Station (E.S.R., 58, p. 280), the authors confined four young pregnant sows in a well-lighted hog house throughout the gestation period. Beginning approximately 59 days before farrowing, the sows were irradiated with ultra-violet light at a distance of 28 inches for periods gradually increased from 15 to 40 minutes daily. Two sows were treated in this manner until their pigs were 13 days old and the other two until the pigs were 38 days old. The pigs farrowed were all irradiated until they were 38 days old. A check group of 6 sows was confined in the same house and fed a ration supplemented with 3 per cent cod-liver oil but was not irradiated. The pigs from three of these litters were equally divided and one lot put outdoors twice daily for periods gradually increased from 30 minutes to 2 hours, while all other pigs were confined in the house. Red cell counts and hemoglobin determinations were made on the blood of all pigs, beginning at from 1 to 3 days of age and continuing at from 7 to 10 day intervals to 35 days of age.

These determinations showed that neither the red cell nor the hemoglobin content of the blood of young pigs was increased by irradiation with ultra-violet light.

Apparatus for the Determination of Carbon Dioxide in the Respiration of Apples, P. L. Harding, T. J. Maney, and H. H. Plagge (Science, 70 (1929), No. 1805, pp. 125, 126, fig. 1).—Descriptive notes are presented on the apparatus and its operation.

Removing Smut from Pacific Northwest Wheat by Washing, E. N. Bates, G. P. Bodnar, and R. L. Baldwin (United States Department of Agriculture Circular 81 (1929), pp. 24, figs. 6).—According to the results of an investigation at Portland, Ore., involving 140 car lots of smutty wheat, washing smutty wheat of the Pacific Northwest with either a single or a double cylinder wheat washer appears to be a highly desirable method of removing smut from wheat for commercial purposes (including milling and mixing with smut-free wheat), for domestic shipments, and for export.

Washing removed 86.9 per cent of the total weight of smut from the smutty wheat. The weight of smut removed constituted about 20 per cent of the total weight of material taken from the wheat by the washing process. In every case the washed wheat was pronounced free from smut dockage after the washing process. The actual foul dockage averaged 0.79 per cent before the wheat was run through a cleaner, 0.47 per cent after cleaning, and 0.36 per cent after washing. The average foreign material other than dockage present in the wheat, as received, was 0.19 per cent, after cleaning 0.11, and after washing 0.08 per cent. The moisture content of the wheat as received at the elevator ranged from 8.16 to 10.15 per cent and averaged 8.64 and after washing ranged from 10.1 to 11.95 per cent and averaged 10.78. The loss in test weight between the smutty wheat as received and the washed wheat after short temporary storage ranged from 0.1 to 2.7 pounds per bushel in the various lots and averaged 0.7 pounds. Of the 140 car lots washed, 115 were of the same numerical grade after washing as before, and 25 were one numerical grade lower. In each case the grading factor which determined the grade in all the wheat was its test weight per bushel.

The washer had only a slight tendency to crack the wheat, resulting in an increase of 1.76 per cent of cracked grains based on the weight of the wheat as received. Before being washed the wheat showed a germination ranging from 91.5 to 99 per cent, averaging 95.4, and after washing a germination ranging from 87.5 to 94.5 per cent and averaging 90.7. The washing process increased the gross weight of the wheat by 1.35 per cent, and the gain in weight of the merchantable wheat, due to washing, was 2.6 per cent. A loss of dry matter equal to 1.02 per cent of the weight of the wheat entering the washer was the result of washing. The total cost of labor, power, and water was 0.364 cent per bushel, or 12.13 cents per ton of smutty wheat washed, of which 26 per cent was for power, 11 for water, and 63 for labor. The estimated gain in value of the wheat due to the washing process would net the merchandiser an average profit of 81.1 cents per ton or about 2.5 cents per bushel.

The process is described in detail, and the advantages of removing smut from wheat are indicated.

Book Review

"The Bureau of Home Economics," by Paul V. Betters is a 92-page book published by the Brookings Institution, Institute for Government Research, as number 62 of a series of service monographs of the United States Government. As in each monograph of the series there is given in a descriptive manner (1) the history of the establishment and development of the service; (2) a detailed account of its specific activities; (3) its organization for the handling of these activities; (4) the character of its plant; (5) a compilation of or reference to the laws and regulations governing its operations; (6) financial statements showing its appropriations, expenditures and other data for a period of years; and (7) a full bibliography of the sources of information bearing on the service and its operations. The address of the Brookings Institution is Washington, D. C., and the price of this book is $1.50. A complete list of its numerous other interesting and valuable publications can also be obtained by writing to the Institution.

AGRICULTURAL ENGINEERING

Established 1920

A journal devoted to the advancement of the theory and practice of engineering as applied to agriculture and of the allied arts and sciences. Published monthly by the American Society of Agricultural Engineers, under the direction of the Publications Committee.

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Contributions of interest and value, especially on new developments in the field of agricultural engineering, are invited for publication in this journal. Its columns are open for discussions on all phases of agricultural engineering. Communications on subjects of timely interest to agricultural engineers, or comments on the contents of this journal or the activities of the Society, are also welcome.

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RAYMOND OLNEY, Editor

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Meetings Policy

EVERY time the making of an A.S.A.E. meeting program is under consideration there arises a question as to the relative values of general and technical sessions and papers. There was considerable debate on this point at Moline in connection with the next technical division sessions. Upon the solution of this problem depends quite largely the future of the Society. Its roots go down to the very nature and interests of the membership.

In our methods we are a heterogeneous horde. We have a wide branching of subject matter and a correspondingly wide variety of technique and terminology; we have different viewpoints and angles of approach. No one individual could master, be interested in, and find application for all the subject matter, techniques and angles of approach of agricultural engineering. But we all have a common purpose in advancing the social and economic welfare of agriculture through the increasing application of engineering. And we are all interested in the engineering significance of economic and social developments. Our philanthropic interest in the welfare of agriculture is reinforced by a knowledge that our own prosperity depends upon that of agriculture.

Our common interest is not in our methods but in the results of our work and in the work remaining to be done.

That being the case, to strengthen its position and to meet the professional needs of its members what sort of meeting should the Society hold? It should provide an opportunity under its auspices for any number of agricultural engineers interested in one particular technique, branch of subject matter or specific problem to come together, exchange viewpoints and information and take action on that one point of interest as often as may be desirable. These papers and discussions should be as technical as may be necessary.

The Society must also insure its position as a strong, unified body by placing due emphasis upon study of the results of agricultural engineering progress and upon social and economic developments. Let its general papers and general sessions deal with the opportunities and problems which economic and social situations present to us as agricultural engineers and with the economic and social significance of agricultural engineering progress in general as well as with specific problems.

In the past the Society has erred in failing to define the requirements of a general paper. A paper that deals in general terms with a technical subject is neither a general paper nor a technical paper. It gives little or nothing to the man who has been following the subject for any length of time and under false pretenses it induces disinterested persons to attend, waste their time and leave in disgust.

Furthermore, when general and technical papers are both to be presented at one meeting, the program should be so arranged that there are no conflicting activities when general papers are to be presented, so that practically every one can find some technical program of interest to him during the time for technical sessions.

Scientific Exchange

IN RECENT months I have had occasion to interview a number of scientific men regarding results of their investigations. Time and again these men after discussing their findings would turn to their files with the remark, "Some of the preliminary results of this study were printed in "The Journal . . . . ." "The Journal" may have been "The Journal of Agricultural Research," "The Journal of Bacteriology," "American Journal of Botany," "Soil Science," etc.—or AGRICULTURAL ENGINEERING.

Or again when some subject of real import was under discussion and of which the person being interviewed was not himself an author, he would frequently comment upon the presentation of some other author in "The Journal." These references were not the offhand references to popular magazine articles. They were stated with the assurance that the author whose material was accepted for publication in "The Journal" was an authority in his subject.

The scientific journal article is the mark of distinction and accomplishment of the scientific man. It is also a place where he can tell his fellow workers of progress before attaining final results, or where he can report those more profound discoveries of interest to his profession, but not to the general public. Not infrequently the ability of a scientific man is judged by his contributions to his particular "Journal."

Agricultural engineers frequently produce data too technical for the layman, and not suitable for publication as a bulletin, but which if scrupulously prepared would make a lasting contribution to agricultural engineering science and to the reputation of the author. This material although read by only a few may change a practice or stimulate additional research with far reaching results not attained through popular bulletins or press reports.

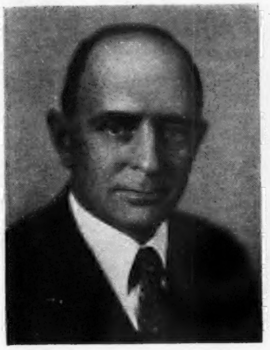
AGRICULTURAL ENGINEERING is our Journal—the agricultural engineers' journal. It should be used more and more as a medium of exchange and as a permanent record of scientific and engineering findings and data pertaining to agriculture.—GEO. W. KABLE.

Big Business—And Profitable

PHILOSOPHIZING Arthur Brisbane foresees agriculture becoming a part of big business "when gigantic machinery plows, harrows, and pulverizes the soil in one operation, when another machine harvests, threshes, bales and weighs the crop in one operation, and airplanes do the sowing."

Mr. Brisbane mentions nothing here that has not already been accomplished in more or less spectacular fashion. But what is more significant is that agriculture will join the ranks of profitable business when the less romantic engineering and economic principles of efficient production, of which extensive operation is only one, govern its organization and operation.

Who's Who in Agricultural Engineering



L. A. Jones

E. V. Collins

Arvy Carnes

H. H. Sunderlin

L. A. Jones

Lewis Allen Jones (Mem. A.S.A.E.) is senior drainage engineer in the division of agricultural engineering, Bureau of Public Roads, U. S. Department of Agriculture. After receiving the degree of civil engineer at the University of Minnesota in 1907, he spent the remainder of the year in drainage work in Minnesota and South Dakota; was assistant engineer on the Great Northern Railway in charge of a party on preliminary and location surveys in North Dakota in 1908; joined the U.S.D.A. in 1909 as assistant drainage engineer devoting most of his time to drainage and flood control work in the southern states; was promoted to drainage engineer in 1912 and to senior drainage engineer in 1915; served as captain of engineers for 21 months during the World War; returned to his position in the U.S.D.A., spending more of his time in administrative work in Washington; and since 1926 has also served as contact agent in agricultural engineering extension between the division of agricultural engineering, U.S.D.A. Office of Cooperative Extension Work, and the state extension service. He was recently elected to membership on the A.S.A.E. Council.

E. V. Collins

Edgar Vermont Collins (Mem. A.S.A.E.) is agricultural engineer and assistant chief of the agricultural engineering section of the Iowa Agricultural Experiment Station After completing high school and a business college course he studied agronomy at Iowa State College for three years, but left school in 1908 without graduating to operate a general farm. In 1913 he returned to Ames and in 1914 completed requirements for bachelor's degrees in both agronomy and agricultural engineering. For a year he remained with the agricultural engineering department as mechanician; then spent three years at Kansas State Agricultural College, teaching in the departments of steam and gas engineering and agricultural engineering; and in 1918 returned to Ames to accept his present position. He has made extensive tests on the draft of plows, has developed both stationary and traction dynamometers providing constant resistance and for the last three years has devoted much of his time to the development and testing of machinery to harvest cornstalks for industrial purposes. He is one of the A.S.A.E. representatives on the Joint Committee on Fertilizer Application.

Arvy Carnes

Arvy Carnes (Assoc. Mem. A.S.A.E.), secretary of the Southern Section of A.S.A.E., is assistant professor of agricultural engineering at Alabama Polytechnic Institute, in charge of farm buildings and farm mechanics. He received his bachelor's degree in agriculture at Alabama Polytechnic Institute in 1915; taught high school in 1916; was assistant county agent for Geneva County, Alabama, in 1917; served in the army in 1918; and taught Smith-Hughes agriculture from 1919 to 1923, when he accepted his present position. During the summer of 1923 he studied agricultural engineering at Cornell University and in 1927 he taught at Oklahoma A. & M. College during the summer term. In addition to his other work he recently completed requirements for and was awarded his master's degree in agriculture, major in agricultural engineering, at the Auburn institution. Since July 1929 he has also been doing some experiment station work. He is author of Memorandum Number 4, "Courses in Farm Shop Work," of the Federal Board of Vocational Education. He also prepared a paper on "Agricultural Engineering Courses to Train Smith-Hughes Teachers" which was presented and favorably received at the recent A.S.A.E. College Division session at Moline.

H. H. Sunderlin

H. Harold Sunderlin (Mem. A.S.A.E.) is supervisor of training for the Caterpillar Tractor Company. Following graduation from Iowa State College in 1915 with a bachelor's degree in agricultural engineering he taught industrial arts in the high school at Anamosa, Iowa, for two years and at Missouri Valley, Iowa, for one year. Then he became a club leader for Wapello County, Iowa, left that work in 1919 to sell tractors for the International Harvester Company; took over the Delco-Light sales and service at Ottumwa, Iowa, for a year; in 1920 returned to Ames to become extension specialist in agricultural engineering; and in 1927 took up his present position. During his years in the extension service he was author and co-author of several bulletins on soil erosion and served on A.S.A.E. committees on soil erosion and on agricultural engineering extension. His present work includes the training of employees of the company in the mechanical features of its products' in sales work and on company policies. In the past year he organized and supervised the holding of one hundred twenty-five dealers' "Caterpillar" schools in the United States and Canada.

A. S. A. E. and Related Activities

San Francisco Picked for Reclamation Meeting Place

AT ITS meeting in Moline in June the Reclamation Division of A.S.A.E. accepted the invitation of the Pacific Coast Section to hold a joint meeting on reclamation somewhere in California next winter. The executive committee of the Section has since announced that it has chosen San Francisco as the city in which it will be host to the reclamation engineers.

January 6 and 7 were decided to be the most satisfactory dates for the meeting. It has also been tentatively decided that one day of the meeting should be devoted to the broader aspects of reclamation and the other day to specific phases of the subject, including reclamation machinery and the design of farm machinery for use on irrigated projects.

Utilization of water and power from the Boulder Canyon project, President Hoover's public land policy, underground water problems and laws concerning them, the relation of forest cover to erosion, and the relation of irrigation practice to the development of farm equipment were some of the numerous subjects suggested for program papers.

Chairman W. L. Paul of the Pacific Coast Section has appointed a publicity committee including Osgood Murdock, Ben D. Moses and Walter W. Weir; a program committee including W. W. McLaughlin, Frank Adams, Walter W. Weir and Ben D. Moses; and a committee on arrangements including W. L. Paul and Fred J. Southerland to make preparations for the meeting.

Model Tractor and Row-Crop Machinery Demonstration Staged at V. P. I.

IN CONNECTION with the Virginia Farmer's Institute the agricultural engineering department at Virginia Polytechnic Institute on the afternoon of July 31 staged a demonstration of tractors and row-crop machinery which was planned as a model to be followed by county agents and local extension leaders.

The demonstration was run like a three-ring circus with a complete change of acts every half hour. In this manner 15 demonstrations were run in two and one-half hours and one half hour left open for additional demonstrations as desired. Five leading makes of equipment were demonstrated in plowing, planting, cultivating, weeding and spraying operations.

American Engineering Council

THE Rivers and Harbors Bill advocated by President Hoover and by Council was passed by the last session of Congress and signed by the President on July 4. It authorizes an initial expenditure of \$130,000,000 and an ultimate total commitment by the Government approaching \$350,000,000.

According to President Hoover the bill represents the final authorization of engineering work for the construction and coordination of a national system of waterways. In the aggregate it will be a larger project than the Panama Canal, will provide employment for thousands, should lower transportation costs on bulk goods, and is expected to be an influence toward the decentralization of population.

Dr. George K. Burgess, director of the U. S. Bureau of Standards, has taken preliminary steps to provide the National Hydraulic Laboratory recently authorized by Congress. An advisory committee of ten which he has appointed includes S. H. McCrory, chief of the division of agricultural engineering, Bureau of Public Roads, U. S.D.A., and Blake R. van Leer, assistant secretary, American Engineering Council. This committee has held two meetings. John R. Freeman, originator of the idea of the National Hydraulic Laboratory and a member of the committee, has submitted for its consideration the most comprehensive set of plans yet developed for a hydraulic laboratory. They are to be printed in Senate Document form.

Reorganization of the Federal Power Commission as authorized by Public Law 412, 71st Congress, will provide five full-time commissioners with an independent staff to take over the duties of the old Federal Power Commission which was composed of the Secretaries of War, Interior and Agriculture and which functioned through their departments. The new commission is empowered to call upon the President for engineers from other Government agencies to carry out field work.

Index Available

THE index to AGRICULTURAL ENGINEERING, Vol. 10, 1929 is available and will be mailed free to those requesting it. It includes a title index to the abstracts of most interest to agricultural engineers appearing in the "Agricultural Engineering Digest" pages of the volume.

Personals of A.S.A.E. Members

W. T. Ackerman, director of the New Hampshire rural electric project, is author of New Hampshire Agricultural Experiment Station Circular 34, entitled "Electric Laundry Equipment on the Farm."

Roy Bainer is joint author with L. M. Jorgenson of Kansas Agricultural Extension Bulletin 66, entitled "Electrical Cooking in the Farm Home."

Ralph W. Baird is now associate agricultural engineer, Bureau of Public Roads, U. S. Department of Agriculture, located at 419 West Houston Street, Tyler, Texas. Mr. Baird was formerly assistant professor of agricultural engineering at the Oklahoma A. & M. College.

J. Earl Cress recently took a position with the Cleveland Electric Illuminating Company. He was formerly connected with the University of Idaho, doing research work in rural electrification.

The Editor received the following note along with this picture: "May I suggest using this picture in AGRICULTURAL ENGINEERING. It is our good friend, E. J. Stirniman, in the U.S.S.R. You can see he has become a typical Russian with his shirt outside his pants. He is doing a good job for U.S.S.R. and is happy—Kranick." Mr. Stirniman was formerly connected with the division of agricultural engineering of the University of California and is now an engineer in a responsible position with the Grain Trust of the Russian Soviet government. The photographer was F. N. G. Kranick, a past-president of the Society and engineer with J. I. Case Company, who has recently returned from Russia and other European parts

E. J. Stirniman

John R. Haswell, agricultural extension engineer, Pennsylvania State College, recently became a licensed professional engineer in the State of Pennsylvania.

D. C. Heitshu has resigned as assistant agricultural engineer in the Virginia Agricultural Experiment Station to accept a position in the engineering department of the J. I. Case Company.

Mack M. Jones is author of Missouri Agricultural Experiment Station Bulletin 286, dated May, 1930, and entitled "The Combine Harvester in Missouri."

Howard Matson has resigned his position as extension architect at Kansas State Agricultural College to accept a position in agricultural engineering teaching and extension work at the University of Kentucky.

S. H. McCrory, chief, division of agricultural engineering, Bureau of Public Roads, U.S.D.A., has been appointed a member of the advisory committee on the new National Hydraulic Laboratory by Dr. George K. Burgess, director of the Bureau of Standards.

G. A. Rietz, who has been employed in the Chicago office of the General Electric Company, on rural electrification work, has been transferred to the general office of the company at Schenectady, New York, and placed in charge of the rural electrification section of the company.

John W. Sjogren, agricultural engineer in charge of farm mechanics at Colorado Agricultural College, is one of the authors of Colorado Agricultural Experiment Station Bulletin No. 308, entitled "Adobe Brick for Farm Buildings."

J. C. Wooley is author of the University of Missouri Agricultural Extension Circular 247, dated April, 1930, and entitled "Farm Building Plans."

E. K. Young has resigned the position he has held for the past several years in agricultural sales work for the Taylor Tractor Company, Caterpillar dealers, to become associated with the Caterpillar Tractor Company. He is now at the Peoria, Illinois, office of the company.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the July issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

John T. Bowen, senior electrical engineer, U. S. Department of Agriculture, East Falls Church, Va.

Merwin T. Farley, special representative, Caterpillar Tractor Company, Stockton, Calif.

Lyman H. Hammond, rural electrification specialist, Westinghouse Elec. & Mfg. Company, Buffalo, N. Y.

Lawrence M. Null, power farmer, Macomb, Ill.

Gordon C. Olson, managing editor, "Motive Power," Gillette Publishing Co., Chicago, Ill.

Transfer of Grade

Otto Schnellbach, engineer, Reichskuratorium fur Technik in der Landwirtschaft, Berlin, Germany. (Affiliate Member to Member.)

New A.S.A.E. Members

B. O. Childs, assistant agricultural engineer, U. S. Department of Agriculture, Houma, La.

W. N. Danner, Jr., adjunct professor, Georga State College, Athens, Ga.

G. N. Denike, assistant superintendent, Dominion Experimental Station, Swift Current, Sask., Can.

Victor Etem, salesman, Wm. H. Ziegler Co., Inc., Minneapolis, Minn.

R. E. Everett, experimental engineer, John Deere Plow Works, Moline, Ill.

K. H. Gorham, advertising manager, "Electricity on the Farm," New York, N. Y.

Charles Hollerith, secretary and general manager, Automotive Fan & Bearing Co., Jackson, Mich.

Louis Jacobi, engineer, Allis-Chalmers Mfg. Co., Milwaukee, Wis.

J. G. Kimmel, civil engineer, Palmer Corporation, Sarasota, Fla.

C. C. MacMillan, sales department, Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Osgood Murdock, editor, "Implement Record," San Francisco, Calif.

J. E. Newman, research worker, Institute for Research in Agricultural Engineering, University of Oxford, Oxfordshire, England.

F. L. Rimbach, rural development agent, New England Power Association, Worcester, Mass.

J. O. Smith, agricultural engineer, Delta Experiment Station, Stoneville, Miss.

Transfer of Grade

G. A. Cumings, agricultural engineer, Bureau of Public Roads, U. S. Department of Agriculture, Washington, D. C. (Associate Member to Member.)

Employment Bulletin

An employment service is conducted by the American Society of Agricultural Engineers for the special benefit of its members. Only Society members in good standing are privileged to insert notices in the "Men Available" section of this bulletin, and to apply for positions advertised in the "Positions Open" section. Non-members as well as members, seeking men to fill positions, for which members of the Society would be logical candidates, are privileged to insert notices in the "Positions Open" section and to be referred to persons listed in the "Men Available' section. Notices in both the "Men Available" and "Positions Open" sections will be inserted for one month only and will thereafter be discontinued, unless additional insertions are requested. Copy for notices must be received at the headquarters of the Society not later than the 20th of the month preceding date of issue. The form of notice should be such that the initial words indicate the classification. There is no charge for this service.

Men Available

AGRICULTURAL ENGINEER, master's degree in agricultural engineering from midwestern university, three years experience teaching farm machinery, dairy mechanics and physics, knowledge of buildings and land reclamation, desires position as research worker or teacher. Age 27. Single. MA-177.

AGRICULTURAL ENGINEER completing a fellowship in agricultural engineering June 1930 desires position in research or instruction in agricultural engineering department of a land grant college. Received master's degree in agricultural engineering with minor in vocational education. Twelve years of successful public school experience as instructor of science, vocational agriculture, farm shop and administrator. Fourteen months U. S. army experience. Associate member of A.S|A.E. Married. Age 37. MA-179.

AGRICULTURAL ENGINEER, specialist in farm buildings and conveniences, several years experience in teaching, experiment station and extension work in one of the leading state colleges, also practical experience in farming and building. Will consider position anywhere. MA-180.